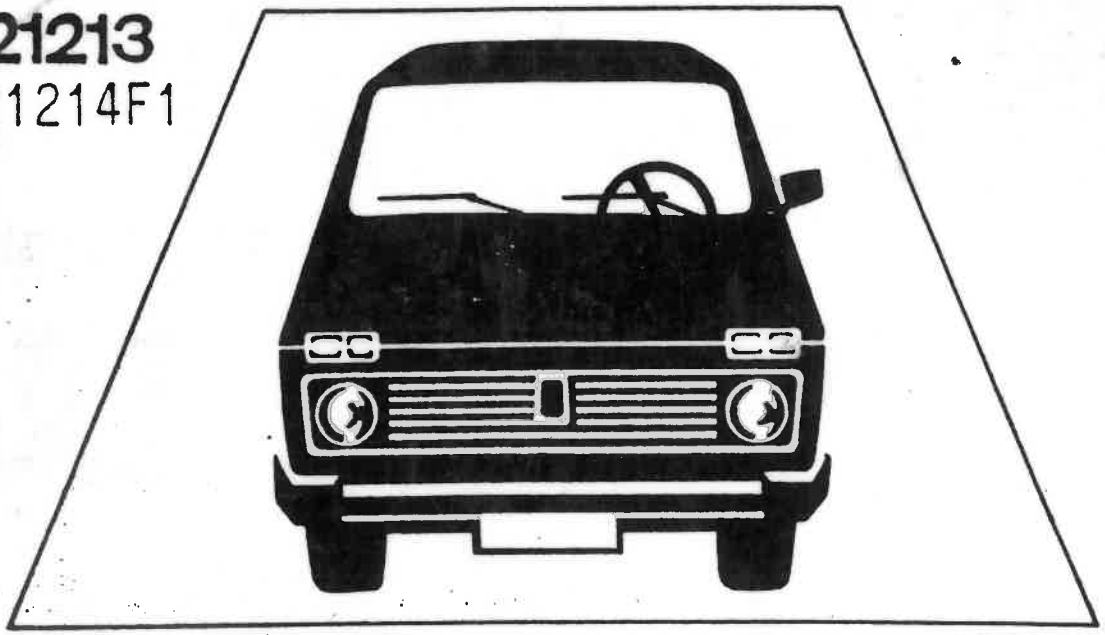
CAR

VAZ

21213
21214F1



REPAIR MANUAL

AVTOLADA · TOGLIATTI · USSR

CAR
21213
VAZ-21214F1

REPAIR MANUAL

AVTOLADA

TOGLIATTI

Introduction

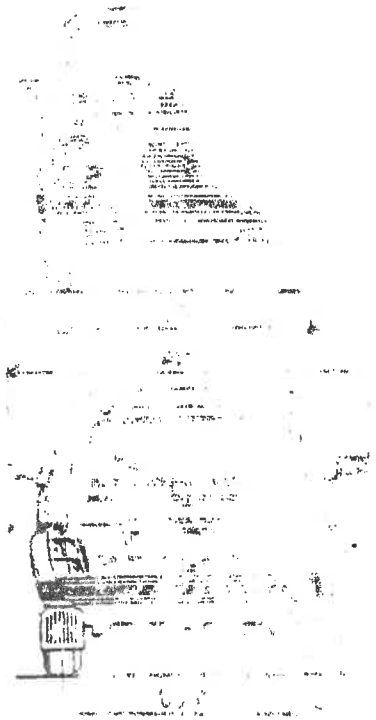
The present Manual is a guide for maintenance and repair of VAZ-21213 cars at service centres and stations, in motor transport pools and repair shops.

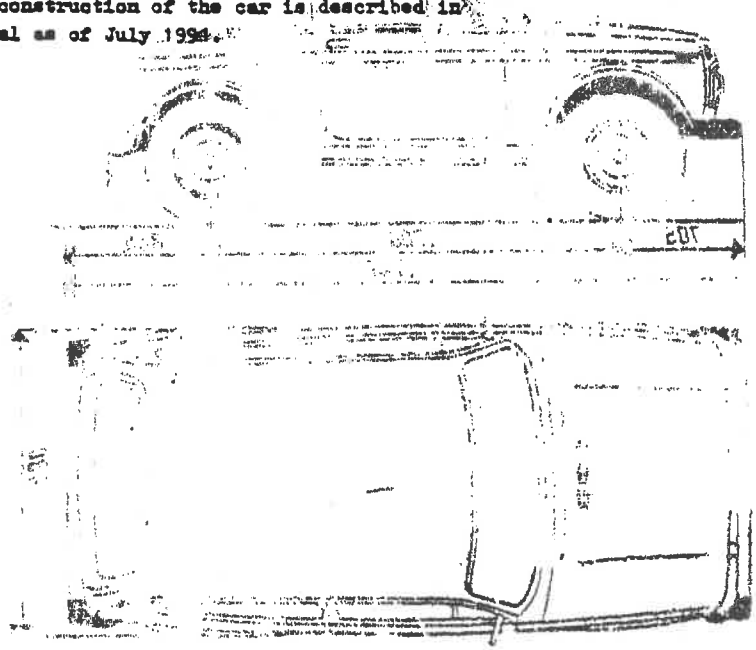
The Manual offers recommendations for servicing and repairing the car by the use of ready-made spare parts. Besides, it contains trouble shooting instructions covering disassembly and assembly, adjustments and repairs of car units.

The recommended repair equipment is listed in Appendix II. The tightening torques for threaded joints are specified in Appendix I.

Since efforts are continually made to improve the reliability and performance of the car, there may be certain discrepancies between the text and illustrations on the one hand and the actual design of the car on the other.

The construction of the car is described in the Manual as of July 1994.





Section I

GENERAL DATA

SPECIFICATIONS

General

Seating capacity, driver included ..... 4 or 5*
Payload, kg 400
Curb mass (mass of fully serviced and equipped car less payload), kg 1210
Overall dimensions ..... See Fig. 1-1
Minimum turning radius, outer front wheel track, m 5.5
Maximum speed in top gear, km/h:
with driver and passenger 137
fully laden 135

Acceleration time from rest to 100 km/h through gears, s:
with driver and passenger 19
fully laden 21
Maximum gradeability, fully laden, without acceleration, in 1st gear, %... 58
Maximum braking distance, fully laden, at 80 km/h on level section of dry smooth asphalt-coated highway, m:
service brakes 40
in emergency (one of service brake circuits) 90

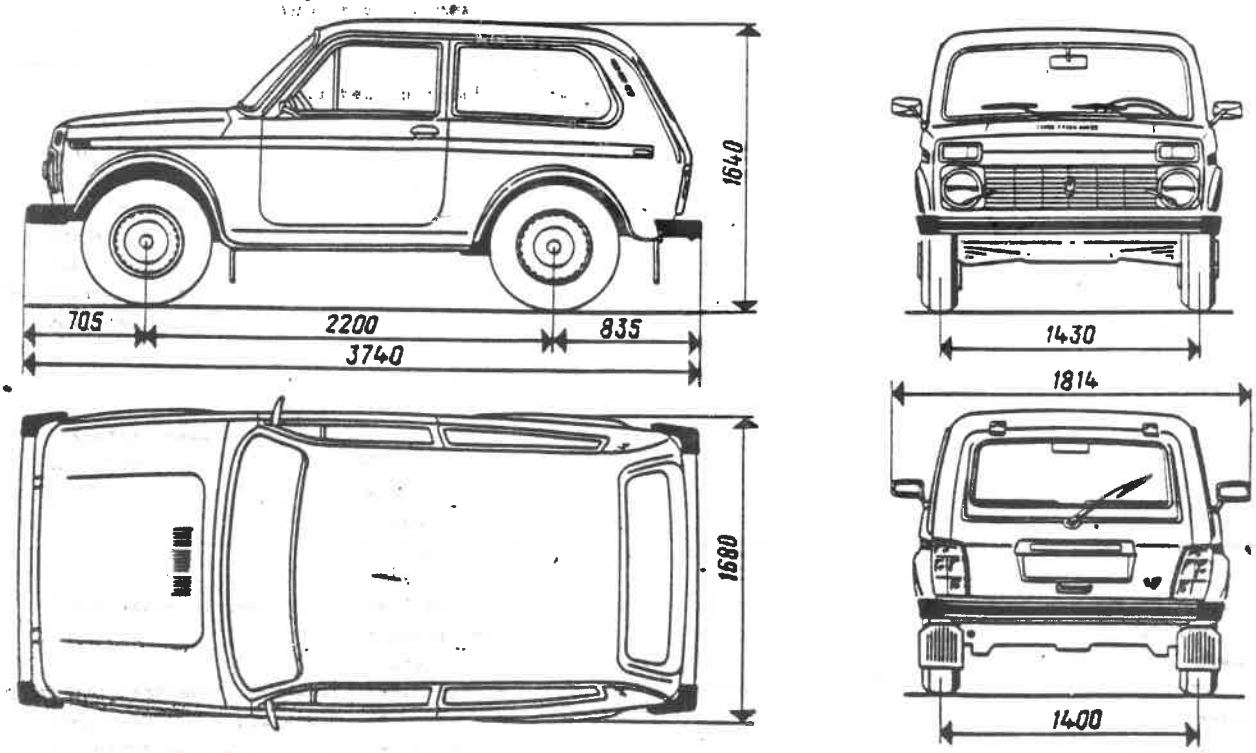


Fig.1-1. VAZ 21213 Car Main Overall Dimensions

* For short-distance trips.

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Engine

Model	VAZ-21213
Type	four-stroke, gasoline, carburettor
Number and arrangement of cylinders	4, in-line
Cylinder bore x piston stroke, mm	82x80
Displacement, l	1.69
Compression ratio	9.3
Rated power to GOST 14846-81 (net) at crankshaft speed of 5200 min^{-1}, kW (hp), minimum	58 (78.9)
Maximum torque to GOST 14846-81 (net) at crankshaft speed of 3200 - 3400 min^{-1}, N.m (kgf.m), minimum	127 (12.9)
Firing order	1-3-4-2

Power Train

Clutch	dry, single-plate, with diaphragm pressure spring
Gearbox	five-speed, all forward gears synchronized
Gear ratios:	
1st gear	3.67
2nd gear	2.10
3rd gear	1.36
4th gear	1.00
5th gear	0.82
reverse	3.53
Transfer case	two-stage, with interaxle locking differential
gear ratios:	
high speed	1.2
low speed	2.135
transfer case differential	bevel, two-pinion
Propeller shafts:	
gearbox-to-transfer case	with flexible coupling and constant-velocity universal joint
transfer case-to-front and-rear axles	with two needle bearing universal joints with grease fittings and slip yokes
front axle-to-wheels	open, with constant-velocity universal joints
Front and rear axle drives	bevel, hypoid
gear ratio	3.9
differential	bevel, two-point

Running Gear

Front suspension	independent, lateral wishbones with coil springs, hydraulic telescopic shock absorbers and sway eliminator
Rear suspension	rigid beam linked to body by one transverse and four longitudinal radius rods; coil springs and hydraulic telescopic shock absorbers
Wheels	disk, drop-forged
Rim size	127J-406 (5J-16)
Tyres	radial or cross-ply, tube-type
Tyre size	cross-ply - 175-406 (6.95-16), radial - 175/80R16

Steering

Steering mechanism	hourglass worm with double roller, ratio 16.4
Steering linkage	three-link, centre rod and two symmetrical side rods, pitman arm, idler arm, knuckle arms

Brakes

Service brakes:	
front	disk, with movable caliper
rear	drum, with self-aligning shoes and rear brake pressure regulator
Service brake system	hydraulic, foot-operated, split
Brake booster	vacuum-type, to all wheels
Parking brake	hand-operated, cable-controlled, to rear brake shoes

Electrical Equipment

Wiring system	single-wire, negative ground return type
Rated voltage, V	12
Storage battery	55 A.h at 20-h discharge rate
Alternator	with built-in rectifier, 55 A output at 5000 min^{-1} rotor speed
Starter	1.3 kW with electromagnetic solenoid switch and overrunning clutch

Body

Model	VAZ-21213
Type	all-metal, three-door, unitized, two-box

Tailgate glove maybe	5.0
Light weave year	5.7
Heavy duty	0.44
Spacious glove compartment	0.19
Steering gear case	3.75
Rear axle housing	7.0
Gasket set	0.59
Differential case	0.19
Rear axle housing	7.0
Steering knuckle	0.5
-30 °C material	
Too -10 °C	
-45 °C vacuum	
Too -10 °C	
Low -65 °F	
Oil filter	
System (Low)	
Be an Ultra value	
Engine	

MAIN ADJUSTMENT AND CHECK DATA

Valve clearances, engine cold, mm 0.15
Minimum crankshaft speed at idling, min^{-1} 750-800
Oil pressure in engine lubricating system at oil temperature of 85 °C and crankshaft speed of 5400 min^{-1}, MPa (kgf/cm^2).... 0.35 - 0.45 (3.5 - 4.5)
Coolant temperature in warmed-up engine, °C 95
Coolant level in expansion tank, engine cold ..... 3 - 4 cm above MIN mark
Deflection of fan drive belt at 100 N (10 kgf), mm ..... 10 - 15
Spark plug gap, mm ..... 0.7 - 0.8
Initial ignition advance angle, TDC, deg. ..... 1±1
Free travel of clutch pedal, mm. 25 - 35
Free travel of brake pedal, engine shut down, mm ..... 3 - 5
Fluid level in brake and clutch reservoirs..... to lower edge of filler necks

Maximum gradient of dry firm ground on which fully laden car is held infinitely by parking brake with brake lever shifted through 4 - 5 teeth of quadrant, % 30
Steering wheel play, wheels in straight-ahead position, deg. (mm) ..... 5 (18 - 20)
Toe-in of front wheels of laden car* after running-in measured between wheel rims, mm ..... 2 - 4
Camber of front wheels of laden car* after running-in, deg(mm) 0°30'±20'(1 - 5)
Caster of front wheels of laden car* after running-in, deg..... 3°30' ±30'
Tyre pressure, MPa (kgf/cm^2):
front wheels 0.21 (2.1)
rear wheels 0.19 (1.9)
Axial play in front wheel hub bearings, mm ..... 0.01 - 0.07

* Load of 3200 N (320 kgf) - 700 N (70 kgf) on two front and two rear seats and 400 N (40 kgf) in luggage compartment.

FUELS, LUBRICANTS AND FLUIDS

Unit	Qnty, l	Material
Fuel tank (including 4-6.5 l reserve)	42	Automotive gasoline АИ-93, АИ -91
Engine cooling system (including heating system)	10.7	Coolant Тосол А-40
Engine lubricating system (including oil filter): from -20 °C to +45 °C ambient	3.5	Engine oil: М-6з/12Г1 all-weather
from -30 °C to +30 °C ambient		М-5з/10Г1 all-weather
Gearbox housing	1.35	Transmission oil ТАД-17И
Rear axle housing	1.3	
Steering gear case	0.18	
Transfer case housing	0.75	
Front axle housing	0.9	
Clutch hydraulic system	0.2	Hydraulic brake fluid "Тормоз"(Tormoz) or "Роса"(Rosa)
Brake hydraulic system	0.66	
Front shock absorber	0.12	Shock absorber fluid АРП-10
Rear shock absorber	0.195	
Windshield and headlight washer tank	5.0	Mixture of water with special fluid for glass cleaning "Автоочиститель-2)"
Tailgate glass washer tank	2.0	

Continued

Unit	Qnty, l	Material
		(Avtoochistitel-2) or "Обзор" (Obzor)
Front wheel hub bearings	–	Grease Литол-24
Starter drive carrier ring	–	
Universal joint cross bearings	–	Grease No.158 or Фиол-2У
Propeller shaft splined joints	–	Grease Фиол-1, Фиол-2У
Seat slides	–	Grease
Door locks and striker plates	–	Фиол-1
Steering rod joints, front suspension ball supports	–	Grease ШРБ-4
Front wheel drive joints	–	Grease ШРУС-4
Storage battery terminals and clamps	–	Aerosol ВТВ-1
Door key holes	–	
Hood prop	–	
Door checks	–	Grease ШРУС-4
Pressure regulator	–	Grease ЛТ-1
Engine detergent oil (used when replacing lubricating oil)	–	Detergent oils ВНИИНП-ФП, МСП-1, МПТ-2М

Section II

ENGINE

The longitudinal and cross sections of the engine are shown in Figs 2-1 and 2-2.

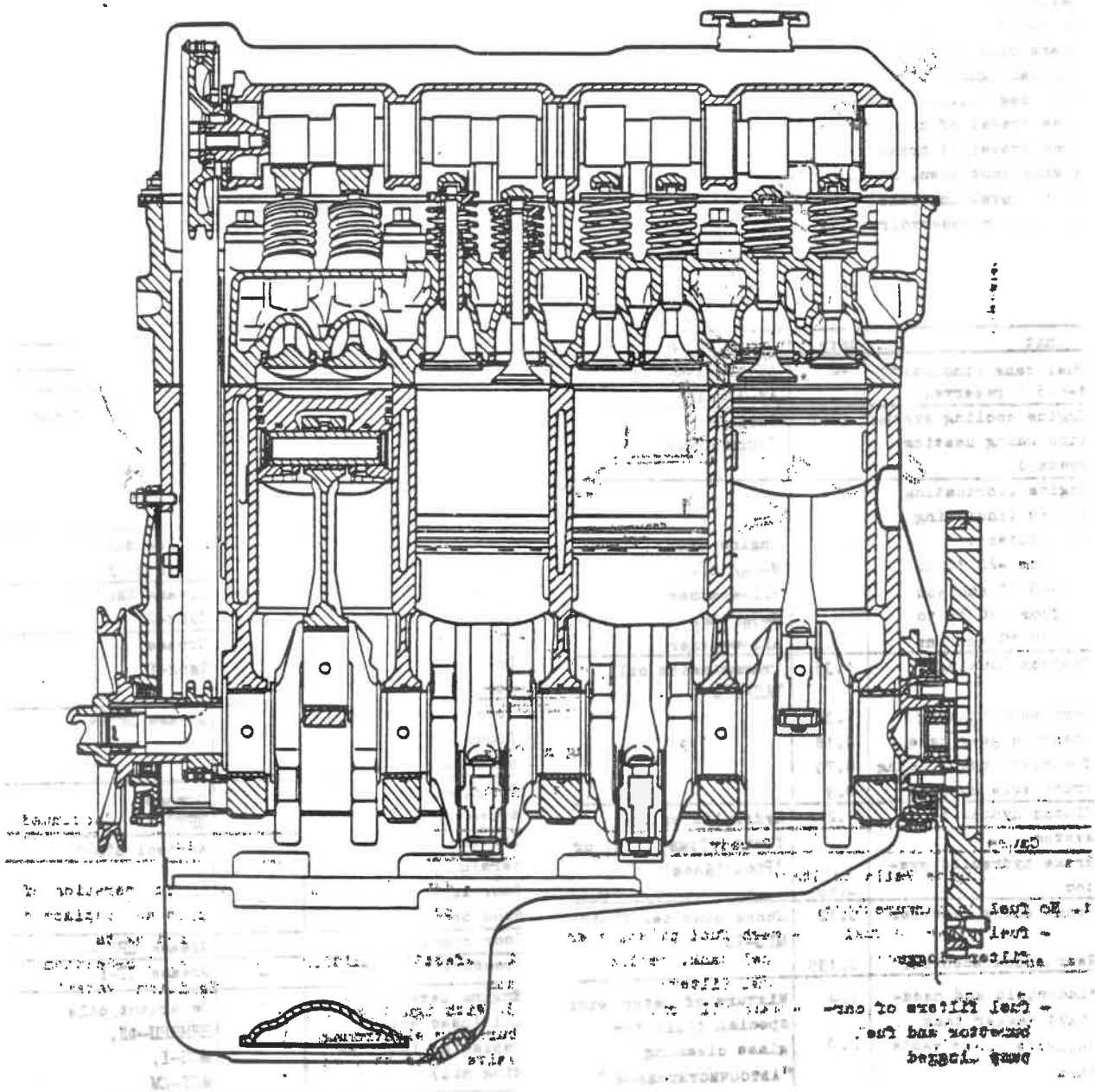

Fig.2-1. Engine Longitudinal Section

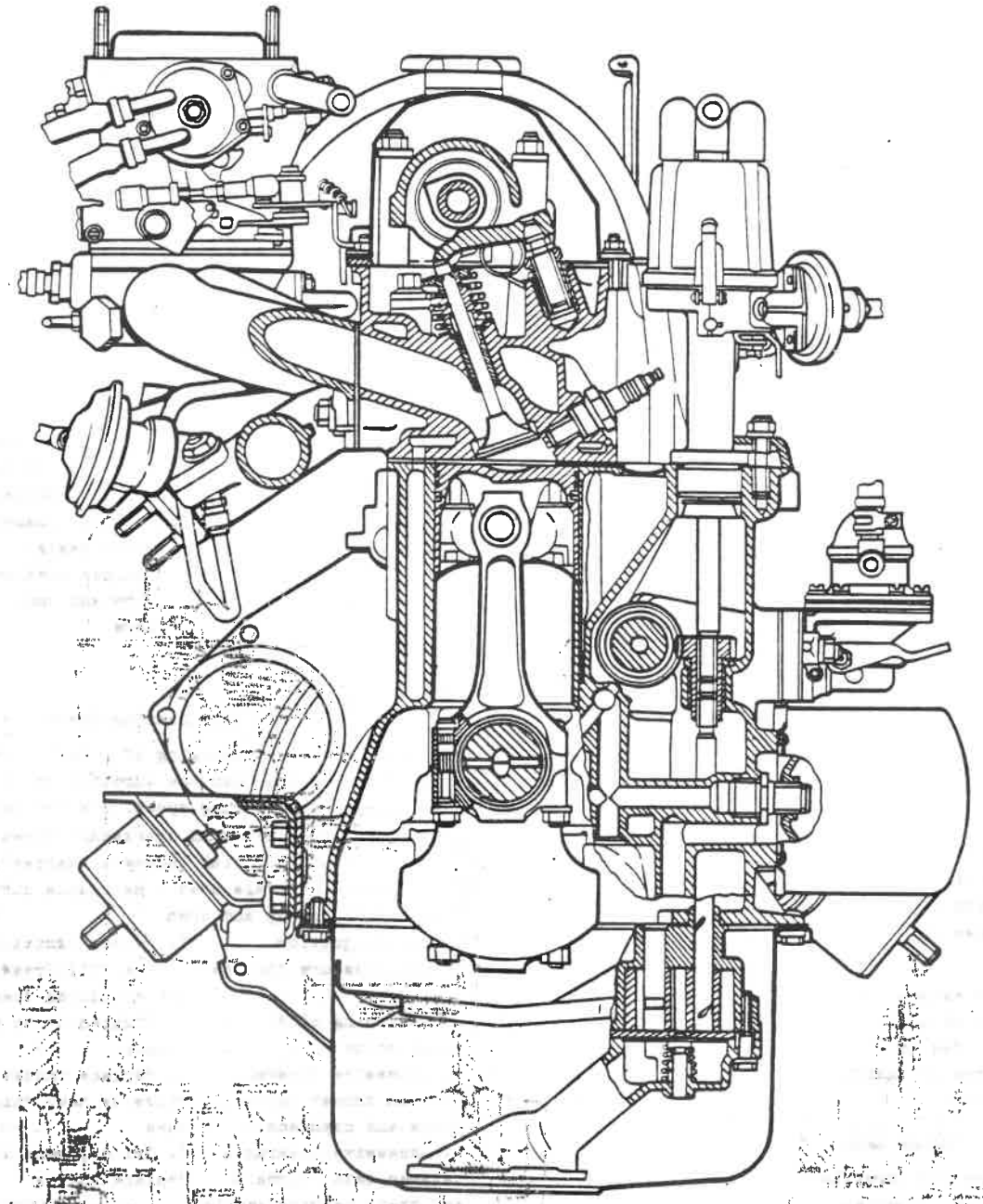

Fig.2-2. Engine Cross Section

TROUBLE SHOOTING

Cause	Remedy
Engine Fails to Start	
1. No fuel in carburettor:	
- fuel pipes or fuel filter clogged;	- wash fuel pipes, wash fuel tank, replace fuel filter;
- fuel filters of carburettor and fuel pump clogged	- wash filters;
- defective fuel pump	- check operation of pump and replace damaged parts
2. Defective ignition system	2. See Sub-Section "Ignition System"
3. With ignition ON carburettor electromagnetic valve fails to open;	

Continued

Continued

Cause	Remedy
- torn off wires laid to control unit or valve;	- check wires and their connections, replace defective wires;
- defective control unit	- replace control unit
4. Carburettor choke valve fails to open when engine starts firing	4. Eliminate trouble in carburettor cold starting unit

Engine Runs Erratically or Stalls at Idling

1. Disturbed idling adjustment	1. Adjust idle speed
2. Defective control system of carburettor electromagnetic valve	2. See "Engine fails to start"
3. Carburettor faulty:	
- carburettor jets or channels clogged;	- airblast jets and channels
- water in carburettor;	- remove water from carburettor, suck out sediment from fuel tank;
- leaky diaphragm of cold-starting device;	- replace diaphragm
4. Ignition system faulty	4. See Chapter "Ignition System"
5. Air inleakage through damaged hose connecting intake manifold with brake vacuum booster	5. Replace damaged hose
6. Air inleakage in connections of intake manifold with carburettor or cylinder head	6. Tighten up nuts or replace gaskets; eliminate deformation of carburettor flange or replace carburettor
7. Air inleakage through damaged tube along which vacuum is fed to vacuum spark timer of ignition distributor	7. Replace damaged tube

Engine Lacks Power and Pickup

1. Carburettor throttle valves open incompletely	1. Adjust throttle valve control linkages
2. Air cleaner clogged	2. Replace cleaner element
3. Ignition system faulty	3. See "Ignition System"
4. Fuel pump faulty	4. Check pump performance and replace damaged parts
5. Carburettor faulty:	
- acceleration pump defective	- check pump capacity, replace faulty parts
- main jets clogged	- airblast jets
- choke valve opens incompletely	- adjust choke valve linkage

Continued

Cause	Remedy
- wrong fuel level in float chamber	- adjust carburettor float setting
- defective diaphragm of power duty economizer	- replace diaphragm
6. Choked vent tube of fuel tank	6. Blow through tube with compressed air
7. Wrong valve clearances	7. Adjust clearances
8. Timing phase marks out of alignment	8. Change position of chain to align marks
9. Compression below 1 MPa (10 kgf/cm^2):	
- broken or sticking piston rings;	- clean rings and piston grooves from carbon, replace damaged parts;
- poor seating of valves;	- replace damaged valves, grind seats;
- badly worn cylinders and piston rings	- replace pistons, rebore and hone cylinders

Crankshaft Main Bearing Knock

As a rule, this knocking of a dull metallic nature is detected when the throttle valve is sharply opened at idling speed. Its frequency grows with an increase in crankshaft speed. Excessive crankshaft end play causes a sharper sound with uneven intervals most conspicuous during gradual throttling up and down.

1. Early ignition	1. Adjust ignition timing
2. Oil pressure too low	2. See "Oil Pressure Too Low at Idling Speed"
3. Loosening of flywheel bolts	3. Tighten up to specified torque
4. Excessive clearance between thrust half-rings and crankshaft	4. Replace thrust half-rings by new thicker ones
5. Excessive clearance between main journals and their bearing shells	5. Grind journals and replace shells

Big-End Bearing Knock

Usually knocking of big-end bearings is sharper than that of the main bearings. It is heard at engine idling speed when the throttle valve is sharply opened. The origin of knocking can be reliably identified by disconnecting spark plugs one after another.

1. Insufficient oil pressure	1. See "Oil Pressure Too Low at Idling Speed"
2. Excessive clearance between big-end journals and shells	2. Replace shells and grind journals

Continued

Cause	Remedy

Piston Slap

As a rule, it is a dull knocking caused by slackness of piston in the cylinder. It is best audible at a low engine speed and under a load.

1. Excessive piston-to-cylinder clearance	1. Replace pistons, rebore and hone cylinders
2. Excessive piston ring-to-groove clearance	2. Replace rings or pistons with rings

Intake and Exhaust Valve Knock

Excessive clearances in valve gear cause characteristic knock, usually with regular intervals. Knocking frequency is less than that of any other engine knock, since the valves are operated by the camshaft which rotates at half the crankshaft speed.

1. Excessive valve-to-rocker clearances	1. Adjust clearances
2. Valve spring broken	2. Replace spring
3. Excessive clearance between valve stem and guide	3. Replace worn parts
4. Wear of camshaft cams	4. Replace camshaft and valve rockers
5. Loosening of adjusting bolt locknut	5. Adjust valve rocker-to-cam clearance and tighten locknut

Camshaft Drive Chain Noise

The camshaft drive chain noise becomes noticeable against the background of general engine noise in case of excessive clearances between the chain and sprockets and it is particularly loud at low engine speed.

1. Chain becomes slack because of wear	1. Tighten up chain
2. Chain tensioner shoe or damper broken	2. Replace tensioner shoe or damper
3. Chain tensioner plunger jamming	3. Eliminate jamming

Oil Pressure Too Low in Warm Engine at Idling Speed

1. Foreign matter getting under reducing valve of oil pump	1. Clean valve of foreign matter and burrs, wash oil pump
2. Oil pump gears worn	2. Repair oil pump
3. Excessive clearance between crankshaft main journals and bearing shells	3. Grind journals and replace shells
4. Excessive clearance between camshaft journals and bearing housing	4. Replace camshaft or bearing housing
5. Use of engine oil of poor quality or non-recommended grade	5. Replace oil with that recommended in Section I

Oil Pressure Too High in Warm Engine

1. Oil pressure reducing valve jamming	1. Replace valve
2. Excessive rigidity of oil pressure reducing valve spring	2. Replace spring

Excessive Oil Consumption

1. Oil leaking through engine seals	1. Tighten fastenings or replace gaskets and glands
2. Choked-up crankcase breathing system	2. Wash parts of crankcase breathing system
3. Wear of piston rings or cylinders	3. Rebore cylinders and replace pistons and rings
4. Broken piston rings	4. Replace rings
5. Gummed slots in oil control rings or cutouts in piston grooves caused by use of oil of non-recommended grade	5. Remove carbon deposits from slots and cutouts, use oil recommended in Section I
6. Valve oil-deflecting caps worn or damaged	6. Replace caps
7. Heavy wear of valve stems or guides	7. Replace valves, repair cylinder head

Excessive Fuel Consumption

1. Choke valve fails to open completely	1. Adjust choke valve linkage
2. High resistance to car motion	2. Check and adjust tyre pressure, brake system, front wheel alignment
3. Wrong ignition timing	3. Adjust ignition timing
4. Ignition distributor vacuum spark timer faulty	4. Replace vacuum timer or ignition distributor
5. Carburettor fuel level too high:	
- carburettor needle valve or its gasket leaky	- look for foreign particles between valve seat and needle; replace gasket or valve, if necessary
- jamming or friction interfering with normal motion of floats	- examine floats and replace them if necessary
6. Carburettor air jets clogged	6. Clean jets

Continued

Cause	Remedy
7. Disturbed tightness of diaphragm of carburettor power duty economizer	7. Replace diaphragm
8. Weak spring of power duty economizer	8. Replace spring
9. Carburettor electromagnetic valve fails to cut off fuel delivery at forced idling:	
- movable contact of limit switch in carburettor fails to connect to ground;	- clean contact surfaces of switch;
- open circuit fault in wire connecting control unit with carburettor limit switch;	- check wire and its connections, replace damaged wire;
- defective control unit	- replace control unit

Engine Overheats

Pointer of coolant temperature gauge is in red zone of scale. Prior to trouble-shooting check coolant temperature gauge and its transmitter for good repair (See Sub-Section "Instruments")

1. Slackening of pump and alternator drive belt	2. Adjust bolt tension
2. Lack of coolant in cooling system	2. Add coolant into cooling system
3. Wrong ignition timing	3. Adjust ignition timing
4. Radiator heavily soiled on outside	4. Clean radiator with jet of water
5. Thermostat faulty	5. Replace thermostat

Continued

Cause	Remedy
6. Defective valve in radiator cap (opening pressure below 0.07 MPa (0.7 kgf/cm^2)	6. Replace cap
7. Coolant pump faulty	7. Check, replace or repair coolant pump

Rapid Drop of Coolant Level in Expansion Tank

1. Radiator damaged	1. Replace or repair radiator
2. Damaged hoses or pipe joint gaskets, loose clamps	2. Replace damaged hoses or gaskets, tighten up clamps
3. Coolant leaking from heater cock or heater radiator	3. Replace cock or heater radiator
4. Coolant leaks through coolant pump gland	4. Replace gland
5. Radiator cap or its gasket damaged	5. Replace cap
6. Cylinder head gasket damaged	6. Replace gasket
7. Leakage of coolant through microcracks in cylinder block or in cylinder head	7. Check cylinder block and head for leakage of coolant; if cracks are detected, replace defective parts
8. Leakage of coolant through microcracks in coolant pump body, cooling jacket outlet connection, expansion tank or intake manifold	8. Check for coolant leakage, if cracks are detected, replace damaged parts; minor leaks may be eliminated by adding type НИИСС-1 stopleak into coolant

ENGINE REMOVAL AND INSTALLATION

Place the car on a lift or inspection pit and apply its parking brake. Take away the spare wheel and remove its supporting tube.

Disconnect the wires from the storage battery and remove the battery. Turn out the bolts holding the hood hinges and remove the hood.

Disconnect the hoses from the air cleaner, remove the cover and filter element and then remove the air cleaner. Close the carburettor from top with a dummy stopper.

Disconnect the choke and throttle valves control cables from the carburettor. Disconnect the wire lugs from the electromagnetic valve and carburettor limit switch, oil pressure and coolant temperature transmitters, ignition distributor, alternator and starter.

Drain the coolant from the radiator, cylinder block and heater. For this purpose shift the heater cock control lever to the right, turn out plugs on the cylinder block LH side and radiator RH tank, turn in the unions of drain hoses in their places and turn off the caps from the expansion tank and radiator.

Disconnect the fan shroud halves and remove them. Disconnect the coolant inlet and outlet hoses from the engine. Turn out two bolts holding the radiator to the body, force upwards the upper latch of the radiator guide casing, shift the radiator upper part towards the engine and take the radiator complete with the thermostat and hoses out of the engine compartment. Remove the radiator guide casing.

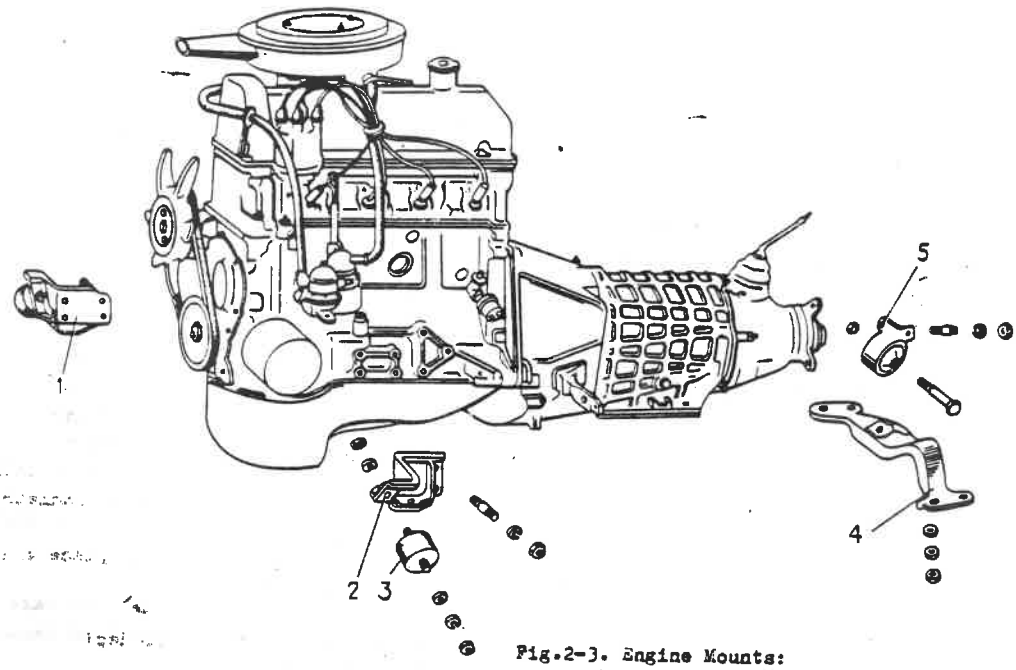

Fig.2-3. Engine Mounts:
1 - R.H. mount bracket with pad; 2 - L.H. mount bracket; 3 - pad; 4 - engine rear mount crossmember; 5 - engine rear mount bracket with support

Turn off the nuts holding the muffler inlet pipe to the exhaust manifold. Disconnect the inlet pipe from the bracket on the gearbox and lower it down.

Loosen the clamps, disconnect the hoses from the fuel pump and fix the fuel pump in position in which fuel leakage is excluded. Disconnect the fuel drain hose from the carburettor.

Loosen the clamps and disconnect the hoses from the heater connections; disconnect the brake vacuum booster hose from the intake manifold.

Using articular socket wrench 02.7812.9500, unscrew the bolts which hold the starter to the clutch housing. Unscrew the bolts which fasten the clutch housing cover to the lower part of the housing. Using articulated socket wrench A.55035, turn off the clutch housing-to-cylinder block bolts.

Suspend cross beam TCO-3/379 from a hoist and sling the engine by the shackle installed on the exhaust manifold front fastening stud on the R.H. side and by the clutch housing fastening hole on the L.H. side.

Tension the hoist chain a little, unscrew the nuts which fasten engine front mount pads 3 (Fig.2-3) to the side brackets and unscrew the nuts and the bolt which fastens the front axle housing to the engine brackets. Disconnect the grounding wire.

Take out the engine, first moving it upward to withdraw the mount pad bolts from the bracket holes, then shift it forward so as to take the end of the gearbox clutch shaft out of the bearing in the crankshaft flange.

Remove the heat-insulating shield of the starter, the starter proper and the hot air intake complete with the inlet hose. Remove two side brackets from the cylinder block complete with the engine front mount pads.

Unscrew the clutch fastening bolts and remove the clutch.

To install the engine reverse the removal operations. Pay particular attention to the connection of the engine with the gearbox: the clutch shaft should get accurately into the splines of the clutch driven disc. Besides, for proper alignment of the engine with the transfer case, the aligning washers of the engine front mount pads must get into the corresponding holes in the side brackets.

ENGINE DISASSEMBLY

Wash the engine in a washer, put it on a disassembly bench and drain oil from the sump.

Disconnect the hoses from the carburettor and remove the latter. Remove the fuel pump and ignition distributor; unscrew the spark plugs and the coolant temperature transmitter with wrench 67.7812.9514.

Take off the alternator and coolant pump drive belt, remove the alternator and its bracket.

Remove the coolant pump, having disconnected the heater pipe from the pump and exhaust manifold.

Detach the coolant outlet pipe and the pipe delivering coolant to the heater and remove them from the cylinder head.

Using remover A.60312, unscrew and take off the oil filter with the gasket (Fig.2-4).

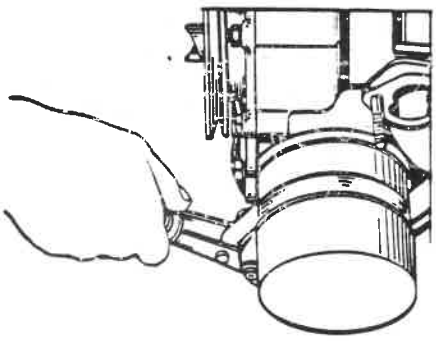

Fig.2-4. Removing Oil Filter with Remover A.60312

Unscrew the oil pressure warning lamp transmitter. Take off the crankcase breather cover, the oil sump and the oil pump. Take off the retainer of the oil separator drain pipe and take out the crankcase breather oil separator.

Remove the crankshaft pulley, having secured the flywheel with fixing tool A.60330/R (Fig.2-10) and unscrewed the crankshaft starting jaws with wrench A.50121 (Fig.2-5).

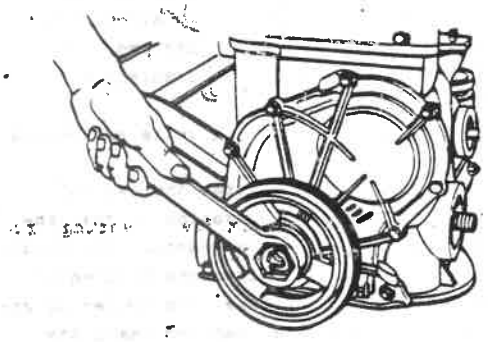

Fig.2-5. Unscrewing Crankshaft Starting Jaw with Wrench A.50121

Remove the cylinder head cover and camshaft chain drive cover. Unscrew the bolts of the camshaft and oil pump drive shaft sprockets.

Loosen cap nut 6 (Fig.2-6) of the chain tensioner, unscrew nuts 4 which hold it to the cylinder head, remove the tensioner and, unscrewing bolt 2, take off chain tensioner shoe 3.

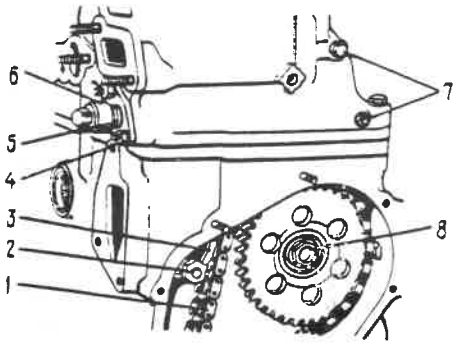

Fig.2-6. Removing Chain Tensioner and Damper:
1 - camshaft drive chain; 2 - shoe bolt;
3 - tensioner shoe; 4 - tensioner fastening nut;
5 - tensioner body; 6 - tensioner cap nut;
7 - damper bolts; 8 - oil pump drive shaft sprocket bolt

Unscrew the chain limiting pin, take off the drive sprockets of the oil pump and camshaft and take out the chain.

Loosen the nuts of studs 4 (Fig.2-7). Take off the camshaft bearing housing. Unscrew the nuts of studs 4, remove thrust flange 1 and take out the camshaft taking care not to damage the surfaces of the bearing housing supports.

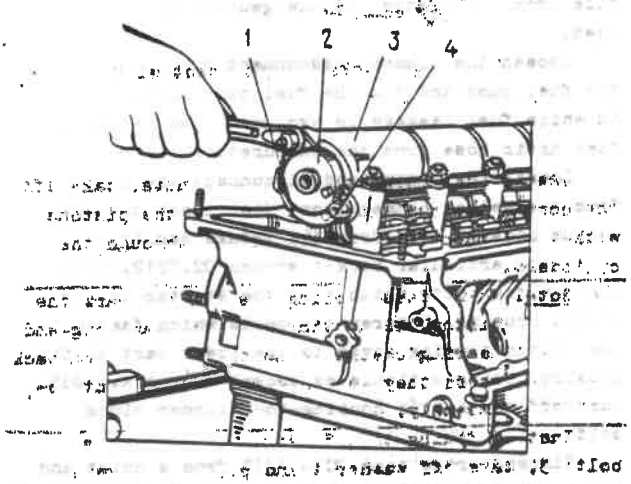

Fig.2-7. Removing Camshaft Thrust Flange:
1 - thrust flange; 2 - camshaft; 3 - bearing housing; 4 - thrust flange fastening stud

Unscrew the cylinder head bolts and take off the head complete with the exhaust and [illegible] manifolds.

Remove thrust flange 1 (Fig.2-8) [illegible] pump drive shaft and take the shaft out of the cylinder block.

Using general-purpose remover A.40005, [illegible] set A.40005, remove the sprocket [illegible] shaft (Fig.2-9).

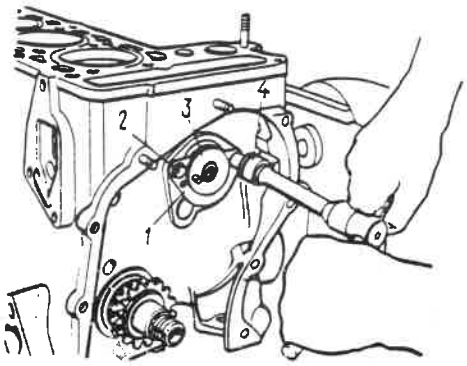

Fig.2-8. Removing Oil Pump Drive Shaft:
1 - thrust flange; 2 - flange bolt; 3 - oil pump drive shaft; 4 - wrench

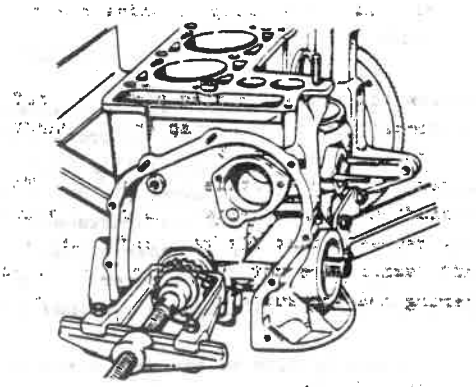

Fig.2-9. Removing Crankshaft Sprocket with General-Purpose Remover

Unscrew the connecting rod bolt nuts, take off the connecting rod caps and lift out the pistons with the connecting rods cautiously through the cylinders.

Note. When disassembling the engine, mark the piston, connecting rod, main and big-end bearing shells so as to install them back where they belong during subsequent re-assembly.

Install fixing tool 5 (Fig.2-10), unscrew bolts 3, take off washer 4 and pull the flywheel from the crankshaft. Remove the front cover of the clutch housing.

Using remover A.40006, take out the gearbox clutch shaft bearing from its socket in the crankshaft (Fig.2-11).

Remove the crankshaft gland holder.

Unscrew the main bearing cap bolts, take out the caps complete with the lower shells, remove the crankshaft, the upper shells and the thrust half-rings of the rear support.

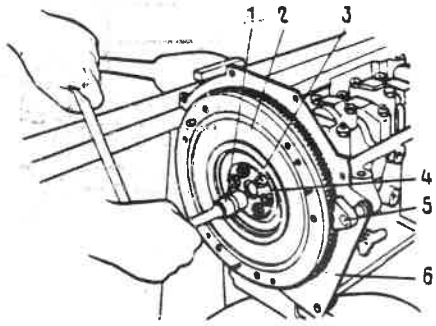

Fig.2-10. Removing Flywheel:
1 - wrench; 2 - flywheel; 3 - flywheel bolt; 4 - washer; 5 - fixing tool A.60330/R to prevent turning of flywheel; 6 - clutch housing front cover

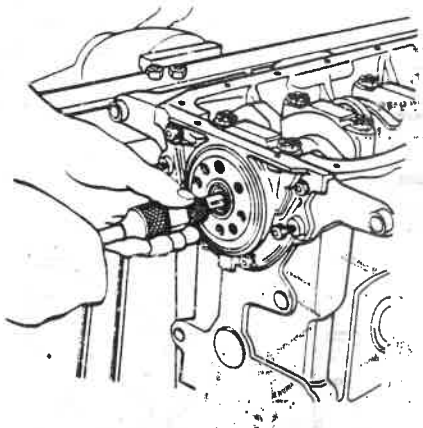

Fig.2-11. Pressing Out Gearbox Shaft Bearing from Crankshaft with Remover A.40006

ENGINE ASSEMBLY

To assemble the engine proceed as follows:

Put the cylinder block, washed and cleaned, on the stand and screw in missing studs.

Coat with engine oil the bearing shells and thrust half-rings of the crankshaft and pistons and glands. When assembling the engine after repair, new crankshaft glands should be installed.

Insert shells without grooves into the bed and cap of the middle bearing; install shells with grooves into the remaining bearing beds and shells without grooves into appropriate caps.

Place the crankshaft in the main bearings and insert two thrust half-rings into the sockets of the rear support (Fig.2-12)

Caution:

The grooves of the half-rings should point to the thrust surfaces of the crankshaft (an antifriction layer is applied on the half-ring surface at the groove side).

The steel-aluminium half-ring should be fitted at the front side of the rear support and the cermet (yellow) half-ring at the rear side.

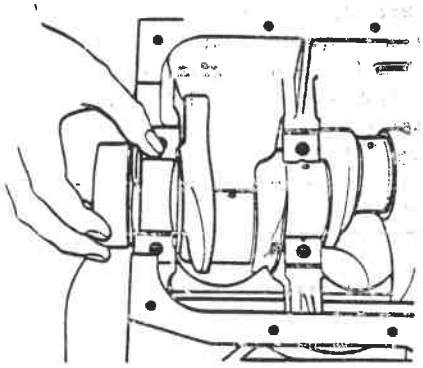

Fig.2-12. Installing Thrust Half-Rings on Rear Support

Install the main bearing caps according to the marks made on their outer surfaces (Fig.2-13). Tighten up the cap bolts.

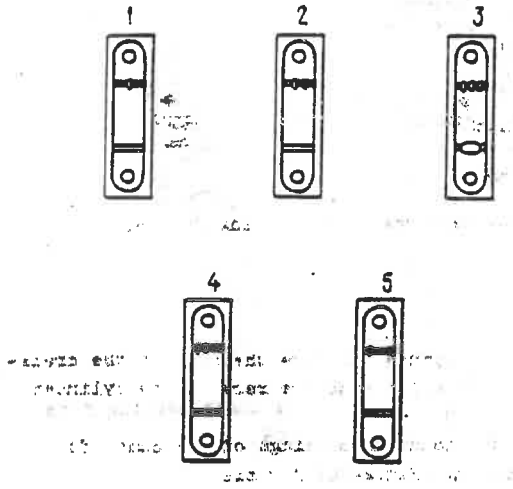

Fig.2-13. Marks on Main Bearing Caps (bearings are counted from engine front)

Check end play of the crankshaft. For this purpose fit a magnetic-base indicator and insert the blades of two screwdrivers as shown in Fig. 2-14. By shifting the crankshaft with the screwdriver, measure free axial travel (end play) of the shaft with the indicator. It should be within 0.06 and 0.26 mm. If the end play exceeds the specified value, correct it by replacing worn half-rings with new ones or installing the half-rings of increased thickness.

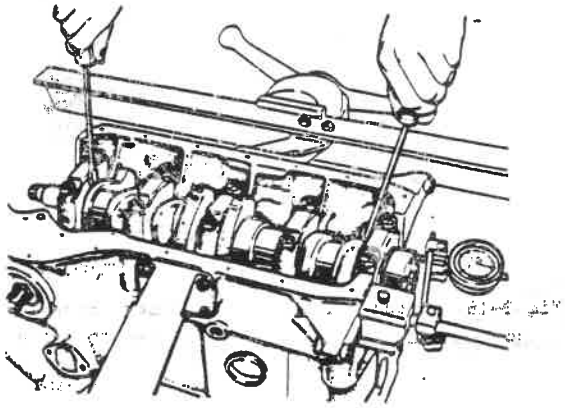

Fig.2-14. Checking End Play of Crankshaft

Put the gland holder gasket on the crankshaft flange and insert the clutch housing front cover bolts into the holder holes (Fig.2-15). Slip the holder with the gland onto mandrel 41.7853.4011, move it from the mandrel onto the crankshaft flange and fasten it to the cylinder block.

Install clutch housing front cover 6 (Fig. 2-10) with the aid of two aligning bushings (Fig. 2-16).

Fix the cover by nuts to the rear gland holder.

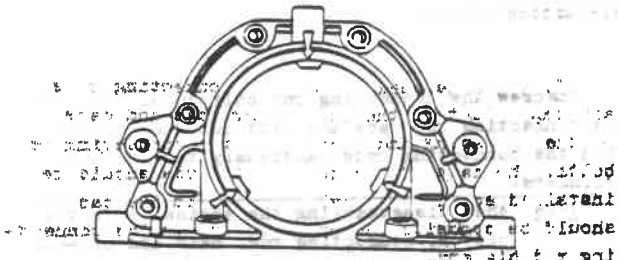

Fig.2-15. Crankshaft Rear Gland Holder: Arrows Indicate Lugs for Aligning Holder with Crankshaft Flange

Install the flywheel on the crankshaft so that the mark (tapered hollow) near the rim should face the axis of the big-end journal of cylinder No.4, lock the flywheel with fixing tool A.60330/R and bolt it up to the crankshaft flange.

Using bushing 67.8125.9502 insert the pistons with connecting rods into the cylinders (Fig.2-17).

Caution:

The hole for the pin in the piston is offset by 1.2 mm, therefore the pistons should be installed into the cylinder with the arrow on the piston head facing the camshaft drive.

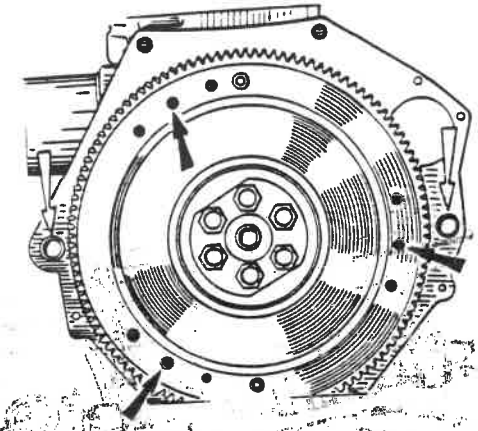

Fig.2-16. Clutch Mounting Pins (Black Arrows) and Clutch Housing Alignment Bushings (White Arrows)

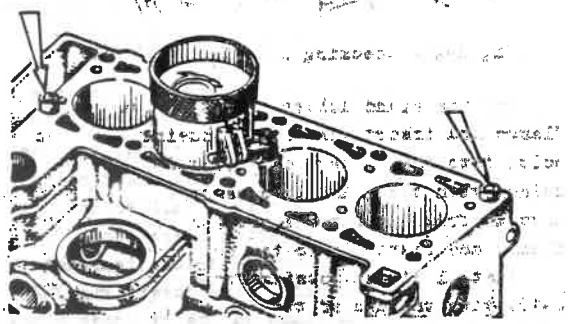

Fig.2-17. Installing Piston with Piston Rings Using Ring Compressor Bushing; Alignment Bushings of Cylinder Head Are Shown by Arrows

Install the shells into the connecting rods and caps. Install the connecting rods and caps on the crankpins and tighten up the connecting rod bolts. The caps of the connecting rods should be installed so that the cylinder No. on the cap should be opposite the cylinder No. on the connecting rod big end.

Install the sprocket on the crankshaft. Install the oil pump drive shaft and fasten it by the thrust flange.

Install two aligning bushings (Fig.2-17) into the cylinder block and fit in place the cylinder head gasket.

Caution:

When assembling the engine always install a new cylinder head gasket. Reuse of the old gasket is prohibited.

Prior to installing a new gasket clean from oil the mating surfaces of the cylinder block and cylinder head. The gasket should be clean and dry, and not smeared with oil. If oil has got onto the gasket degrease the gasket.

Turn the crankshaft to position the pistons in the middle of the cylinders.

Install the cylinder head complete with the valves, exhaust and intake manifolds on the cylinder block by two alignment bushings.

Tighten the cylinder head bolts observing the sequence indicated in Fig.2-18. To provide a reliable sealing and exclude tightening of the bolts at maintenance services, tighten the cylinder head bolts in four steps as indicated below:

1st step - tighten bolts 1 - 10 to a torque of 20 N.m (2 kgf.m);

2nd step - tighten bolts 1 - 10 to a torque of 69.4-85.7 N.m (7.1 - 8.7 kgf.m) and bolt 11 to a torque of 31.36 - 39.1 N.m (3.2 - 3.99 kgf.m);

3rd step - tighten up bolts 1 - 10 by turning them through 90°;

4th step - once again turn bolts 1 - 10 through 90°.

Caution:

The cylinder head bolts may be reused only if the bolt stem has elongated maximum to 120 mm. If the length of the bolt exceeds the specified value, replace the bolt with a new one.

Prior to assembling the engine lubricate the thread and heads of the bolts beforehand by dipping them in engine oil, then let excess oil drip down for 30 min minimum. Remove oil from the holes for the bolts in the cylinder block.

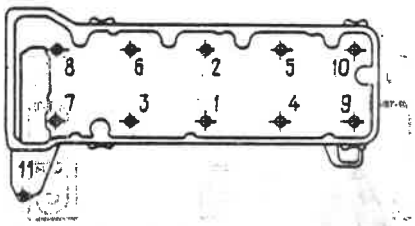

Fig.2-18. Sequence of Tightening Cylinder Head Bolts

Turn the flywheel to make the mark on the crankshaft sprocket align with the mark on the cylinder block (Fig.2-19).

Check the mounting bushings of the camshaft bearing housing (Fig.2-20) for missing.

Install the sprocket on the camshaft assembled with the bearing housing and turn the camshaft so that the mark on the sprocket should face the mark on the bearing housing (Fig.2-21). Remove the sprocket and, without changing the position of the camshaft, install the bearing housing on the cylinder head so that the mounting bushings should get into the sockets of the bearing housing. Secure the housing by tightening the nuts in the sequence shown in Fig.2-22.

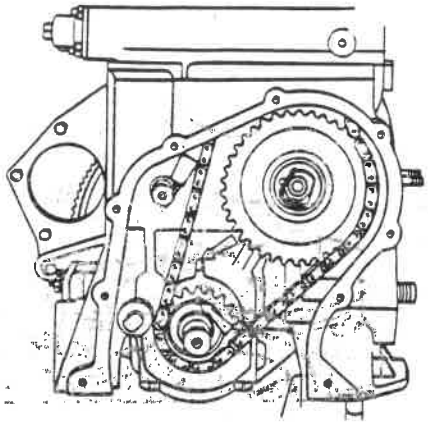

Fig.2-19. Alignment of Timing Marks on Crankshaft Sprocket and on Cylinder Block

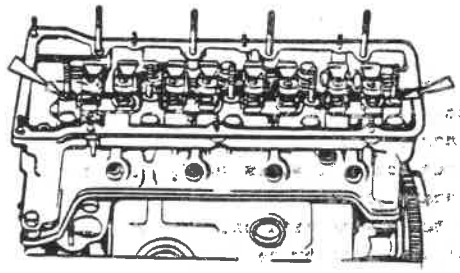

Fig.2-20. Mounting Bushings for Camshaft Bearing Housing

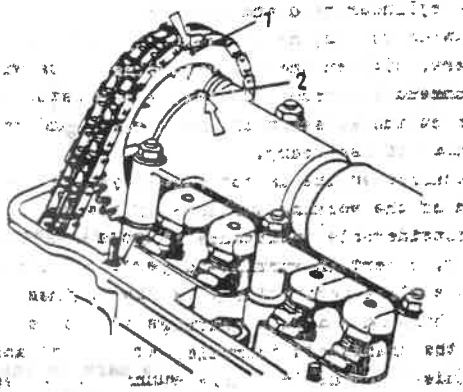

Fig.2-21. Alignment of Timing Marks on Camshaft Sprocket and on Bearing Housing:
1 - mark on sprocket; 2 - mark on bearing housing

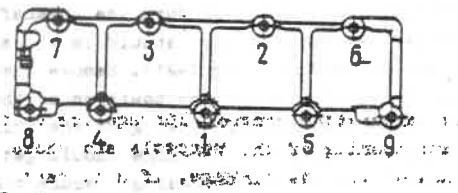

Fig.2-22. Sequence of Tightening Camshaft Bearing Housing Nuts

Install the chain damper on the cylinder head.

Install the camshaft drive chain as follows:

- put the chain on the camshaft sprocket and move it into the drive space so that the mark on the sprocket should line up with the mark on the bearing housing (Fig.2-21). Do not tighten the sprocket bolt all the way home;

- install the sprocket on the oil pump drive shaft, also without tightening the fastening bolt completely;

- install the chain tensioner shoe and the tensioner proper, without tightening the cap nut to allow the tensioner spring to press down the shoe; screw the chain limiting pin into the cylinder block;

- turn the crankshaft two revolutions in its regular direction thereby ensuring the required chain tension; check that the marks on the sprockets are aligned with the marks on the cylinder block (Fig.2-19) and on the bearing housing (Fig.2-21);

- if the marks are in alignment, lock the flywheel with fixing tool A.6010/R (Fig.2-10), tighten up finally the sprocket bolts, the chain tensioner cap nut and lock the sprocket bolts by the lock washers; if the marks fail to coincide, repeat the chain installation operations.

Adjust the valve rocker-to-cam clearances.

Install the camshaft drive cover (Fig.2-23) with the gasket and gland on the cylinder block without tightening the fastening bolts and nuts all the way. Using mandrel 41.7853.4010, align the cover relative to the end of the crankshaft and tighten up its fastening bolts and nuts.

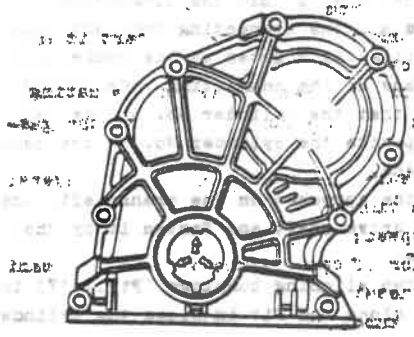

Fig.2-23. Camshaft Drive Cover, Arrows Show Lugs for Aligning Cover with Crankshaft Pulley Hub

Install the alternator and pump pulley and screw in the starting jaws.

Install the oil filter with gasket screwing it on the cylinder block union handtight. Install the oil separator of the crankcase breathing system and the breather cover, and secure the liner of the oil separator drain pipe

Install oil pump 1 (Fig.2-24) and the oil sump with its gasket.

Install the coolant pump, alternator bracket and alternator. Run the belt over the pulleys and adjust its tension.

Install the heater radiator inlet pipe and the cooling jacket outlet connection on the cylinder head. Fasten the heater radiator outlet pipe to the coolant pump and exhaust manifold.

Install the gauge transmitters.

Install the oil pump and ignition distributor drive gear. Install the ignition distributor. Screw in the spark plugs and tighten them with torque-indicating wrench 67.7812.9515.

Install the fuel pump as instructed under "Fuel System".

Install the carburettor and connect its hoses. Fit a dummy plug on the top.

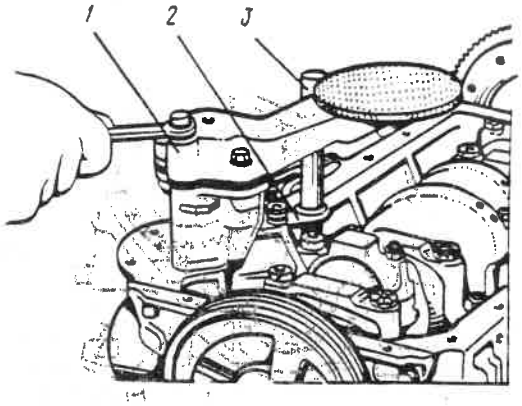

Fig.2-24. Mounting Oil Pump:
1 - oil pump; 2 - drain pipe holder; 3 - oil separator drain pipe

Caution:

It is prohibited to turn on (or tighten up) the nuts on a warm carburettor.

Install the cylinder head cover with the gasket and fuel line bracket.

Install the air cleaner; for this purpose, secure the hoses on the air cleaner body, place the cleaner body with the gasket on the carburettor, install the supporting plate and fasten the body with nuts. Put in the air filter element and fasten the cleaner cover.

Connect the H.T. wires to the ignition distributor and spark plugs.

Fill the engine with oil through the filler throat on the cylinder head cover.

POST-REPAIR ENGINE STAND TESTS

A repaired engine shall be subjected to stand tests (running-in) at no-load in accordance with the following program:

2 min at 750 - 800 rpm
3 min at 1000 rpm
4 min at 1500 rpm
5 min at 2000 rpm

Mount the engine on the stand, start it and check the following:

- coolant or fuel leaks between the mating parts, through the pipe joints and past the gaskets;
- oil pressure and oil leakage past gaskets;
- ignition timing;
- idling speed;
- connection of carburettor with intake manifold for tightness;
- abnormal knocking.

In case of abnormal knocking or other defects, stop the engine, correct the defects and resume the tests.

If oil leaks are detected past the gasket between the cylinder head and cover or past the gaskets between the engine oil sump, cylinder block and covers, tighten the corresponding bolts with the recommended torque. If leakage persists, check for correct installation of the gaskets and replace them, if necessary.

A repaired engine is not run-in yet, therefore, friction of the working surfaces of new parts offers a considerable resistance to rotation; consequently, a certain working-in period is required.

This applies particularly to the engines where pistons, big-end and main bearings shells were replaced, the crankshaft journals were ground and the cylinders honed. So, while running-in a repaired engine do not operate it at maximum speeds. The running-in program should always end on the car driven at the speeds recommended for the early stages of car operation.

ENGINE CHECK-OVER ON CAR

After installing the engine in the car, check it carefully for correct mounting.

Run the engine for some time and check the following, again:

- leaks of coolant and fuel through the pipe joints; tighten the joints, if necessary;
- the carburettor control linkage for complete closing and opening of the throttle and choke valves, and adjust the linkage, if necessary;
- alternator drive belt tension; adjust, if necessary;

- wire connections of electrical equipment and functioning of the warning lamps on the instrument panel.

Caution:

Never check the engine and the car on a stand with running drums without additional rollers placed under the front wheels.

CYLINDER BLOCK

Design Peculiarities

The main dimensions of the cylinder block are given in Fig.2-25. The cylinder block is a special low-alloyed iron casting. According to the bore, the cylinders are subdivided into five classes in 0.01 mm steps marked with the letters A, B, C, D and E. Cylinder class mark is indented on the lower plane of the cylinder block (Fig.2-26).

The cylinders can be recored for repair-size pistons, 0.4 and 0.8 mm oversize in diameter.

The main bearing caps are machined together with the cylinder block. They are not intended for exchange use and they bear identification marks on the outer surfaces (Fig.2-1).

Condition Checks and Repair

Checking. Wash thoroughly the cylinder block and clean its oil passages. Air-blast and dry the cylinder block with compressed air and inspect it thoroughly. Cracks in supports and other parts of the cylinder block are not tolerable.

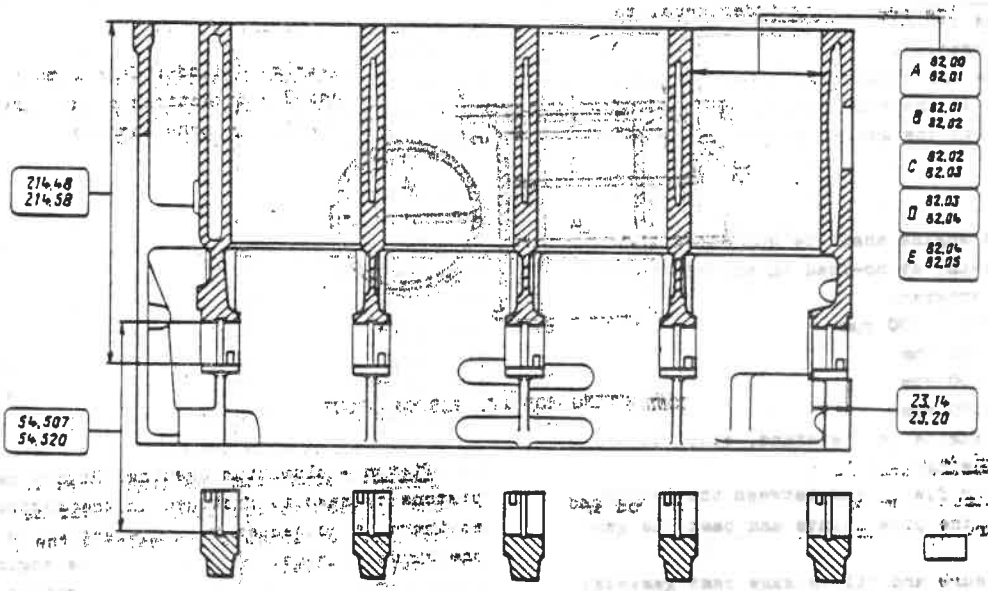

Fig.2-25. Main Dimensions of Cylinder Block

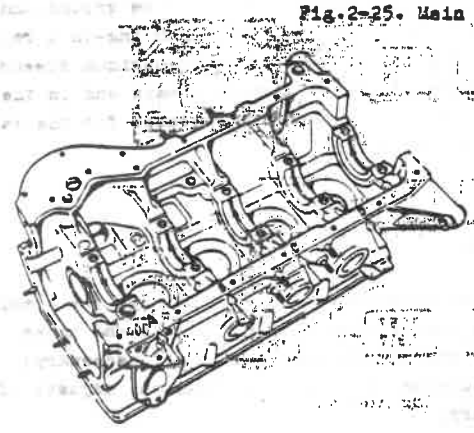

Fig.2-26. Cylinder Class Marks on Cylinder Block

If there is a suspicion that the coolant penetrates into the crankcase, the cylinder block should be checked for tightness on a special stand. For this purpose, plug the holes in the cooling jacket and pump in water at room temperature under pressure of 0.3 MPa (3 kgf/cm^2). There should be no water leaks from the cylinder block for 2 min.

If oil gets into the coolant, before proceeding to disassembling the engine, check the cylinder block for cracks in the oil channel zones. For this purpose drain the coolant from the cooling system, remove the cylinder head, fill the cylinder block cooling jacket with water and deliver compressed air into the vertical oil channel in the cylinder block. If air bubbles appear in the

water filling the cooling jacket, replace the cylinder block.

Check the cylinder block and head division plane with a rule and a set of feeler gauges. The rule should be placed along the diagonals of the plane, in the middle in the longitudinal direction, and across the plane. Flatness should be accurate to 0.1 mm.

Repair. Check the cylinders for wear which should not exceed 0.15 mm (the maximum tolerable value).

The cylinder bore is measured with an internal gauge (Fig.2-27) in four zones, both along and across the engine (Fig.2-28). Gauge 67.8125.9502 is used to set the internal gauge to zero.

In zone No.1 the cylinders do not practically wear, so this zone may be used as a reference one for determining cylinder wear in other three zones.

If the maximum wear exceeds 0.15 mm, bore the cylinders to the nearest repair size with an 0.03 mm allowance in diameter for honing. Then hone the cylinders to the diameter providing the designed clearance between the piston of the selected repair size and the cylinder equal to 0.025 - 0.045 mm.

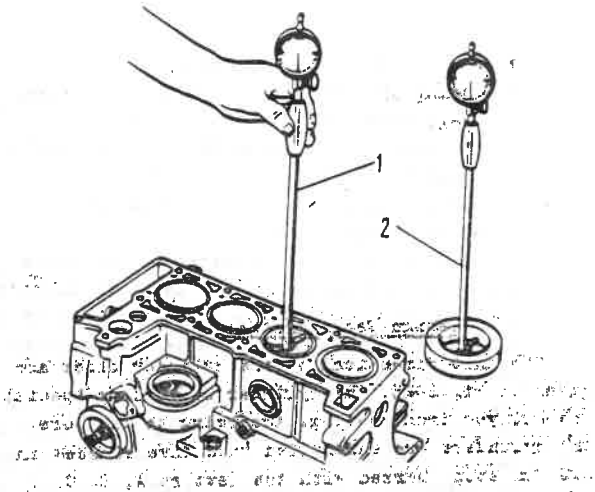

Fig.2-27. Measuring Cylinders with Internal Gauge: 1 - internal gauge; 2 - zeroing internal gauge by check gauge

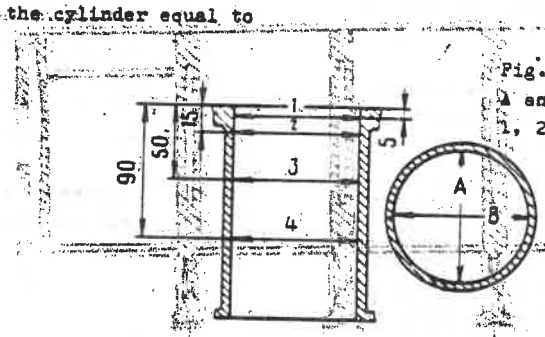

Fig.2-28. Cylinder Measurement Diagram: A and B - directions of measurements; 1, 2, 3, 4 - zone numbers

CONNECTING ROD AND PISTON GROUP

Design Peculiarities

The main dimensions of the connecting rod and piston group are given in Fig.2-29.

Piston - aluminium casting. High accuracy of pistons by mass is provided in their manufacture, so there is no necessity to select the pistons of one group by mass.

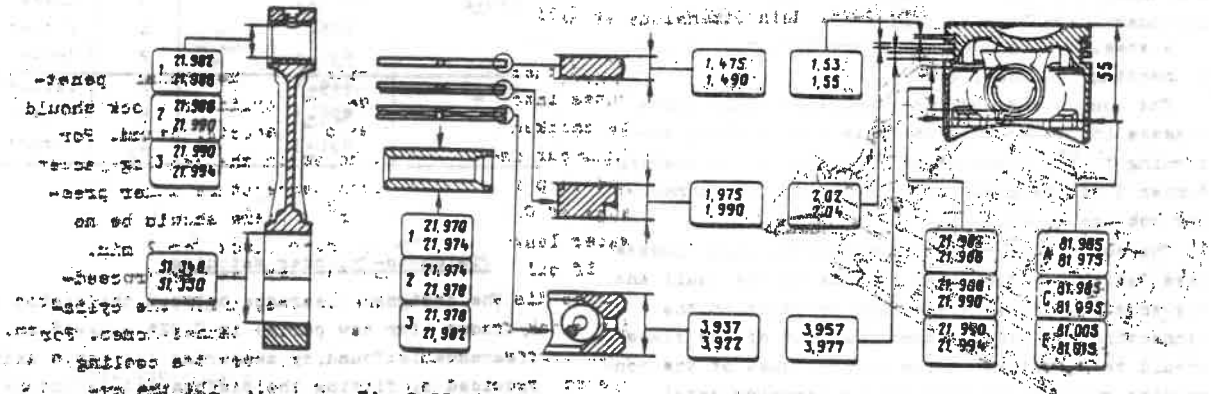

Fig.2-29. Main Dimensions of Connecting Rod and Piston Group

According to the outer diameter the pistons are subdivided into five classes (A, B, C, D, E) in 0.01 mm steps. The outer surface of the piston is of complex configuration. It is conical in height and oval in cross section. So diameter of the piston should be measured only in the plane square to the piston pin at a distance of 55 mm from the piston crown.

According to the diameter of the piston pin hole the pistons are subdivided into three classes (1, 2,3) in 0.004 mm steps. Classes of piston diameters and piston pin holes are indented on the piston crown (Fig.2-30).

The repair size pistons are 0.4 and 0.8 mm oversized in the outer diameter. They bear triangle or square mark on the crown. The triangle corresponds to 0.4 mm and square - to 0.8 mm.

The arrow on the piston crown indicates how to correctly orientate the piston when fitting it in the cylinder. The arrow should point to the camshaft drive side.

Piston pin - steel, hollow, floating, i.e. it is free to rotate in the piston boss and connecting rod bushing. The pin is fixed in the piston by two steel circlips.

The pins are subdivided into three classes, in 0.004 mm steps, by the outer diameter. Classes are marked with paint on the pin end face: blue mark - 1st class, green mark - 2nd class, red mark - 3rd class.

Piston rings - cast iron parts. The upper compression ring has barrel-shaped chromium-plated outer surface. The lower compression ring is of scraper type. The oil control ring has chromium plated working edges and expanding coil spring (expander).

The repair size rings have digit marks 40 or 80 indicating that their out diameter is 0.4 or 0.8 mm oversized.

Connecting rod - steel drop-forging. The connecting rod is machined together with the cap and these parts are not intended for exchange use. Not to confuse the caps and connecting rods during the assembly, they bear marks 6 (Fig.2-30) of the cylinder where they belong.

A steel-bronze bushing is press-fitted in the connecting rod small end.

The connecting rods are subdivided into three classes in 0.004 mm steps (like the pistons) according to the diameter of the hole in the bushing. Number 5 of the class is indented on the connecting rod small end.

The connecting rods are subdivided into classes (see Table 2-1) according to mass of the small and big ends. Class marks are made by paint on the connecting rod body. Connecting rods of one class should be installed in the engine. Mass of the connecting rods can be adjusted by removing metal from the bosses on the ends to the minimum sizes of 16.5 and 35.5 mm (Fig.2-31).

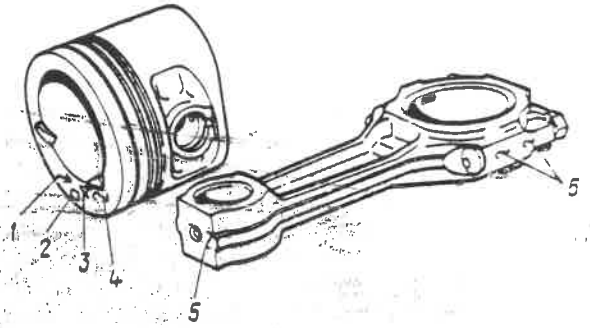

Fig.2-30. Marks on Piston and Connecting Rod: 1 - arrow to orientate piston in cylinder; 2 - repair size; 3 - piston class; 4 - class of hole for piston pin; 5 - class of connecting rod according to piston pin hole; 6 - cylinder No.

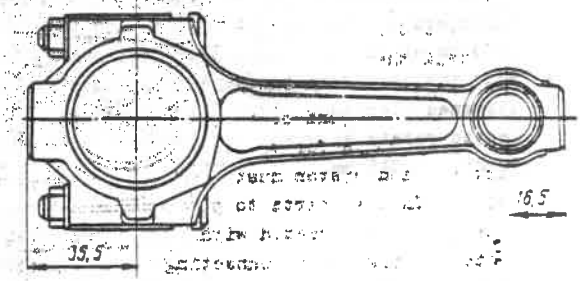

Fig.2-31. Places to Remove Metal to Adjust Connecting Rod Small and Big Ends by Mass

Table 2-1

Classes of Connecting Rods According to Mass of Small and Big Ends

Mass of connecting rod end, g		Class	Mark colour
small	big		
186±2	519±3	A	White
	525±3	B	Blue
	531±3	C	Red
190±2	519±3	D	Black
	525±3	E	Violet
	531±3	F	Green
194±2	519±3	G	Yellow
	525±3	H	Brown
	531±3	I	Orange

Piston-to-Cylinder Matching

The designed clearance between the piston and cylinder (for new parts) is 0.025 ±0.045 mm. The clearance is found by measuring the parts and is provided by fitting the pistons and cylinders belonging to the same class. Maximum tolerable clearance (caused by wear) is 0.15 mm.

If clearance in a used engine exceeds 0.15 mm, match the pistons to the cylinders to provide clearance as close to the designed value as possible.

Delivered for spares are pistons, class A, C and E. These classes permit matching the piston to any cylinder in repair of the engine as the pistons and cylinders are subdivided into classes with certain overlapping of the sizes. For instance, a piston of class C can be used in cylinders of class B and D.

Disassembly and Assembly

Disassembly. Take the circlips of the piston pin out of the piston, take out the piston pin and disconnect the connecting rod from the piston. Remove the piston rings.

If some parts of the connecting rod and piston group are not damaged and not worn, they can be reused. So, when disassembling, mark the parts to install them in the cylinder where they operated.

Assembly. Prior to assembling match the pin to the piston and connecting rod. In new parts class of holes for the piston pin in the connecting rod and piston must be identical with the pin class. In used parts to provide correct fitting the piston pin coated with engine oil should get into the piston or connecting rod hole under thumb pressure (Fig.2-32), and it should not fall out when the piston is held as shown in Fig.2-33.

If the pin slips out, replace it with another one belonging to the next category. If the pin of the 3rd category was used, replace the piston, pin and connecting rod.

To assemble the connecting rod and piston group proceed in the order reverse to disassembly. Having fitted the piston pin coat it with engine oil through the holes in the piston bosses. Install the piston rings as follows.

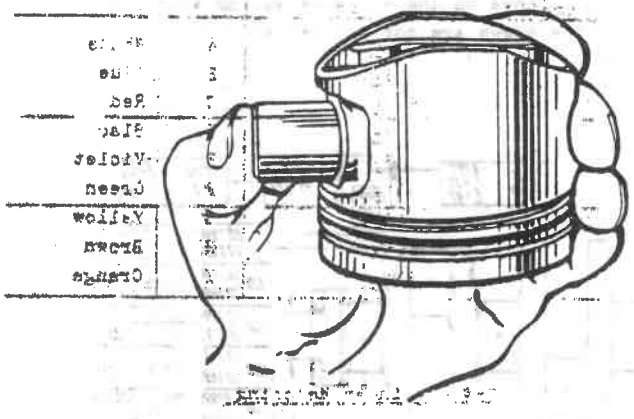

Fig.2-32. Piston Pin Should Go in Under Thumb Pressure

Coat the ring grooves on the piston and the piston rings with engine oil. Fit the piston rings so that the joint in the upper compression ring should be arranged at an angle of 45° to the piston pin axis and the joint of the lower compression ring, at an angle of approximately 180° to the axis of the upper compression ring joint, and the joint of the oil control ring, at an angle of approximately 90° to the axis of the upper compression ring joint.

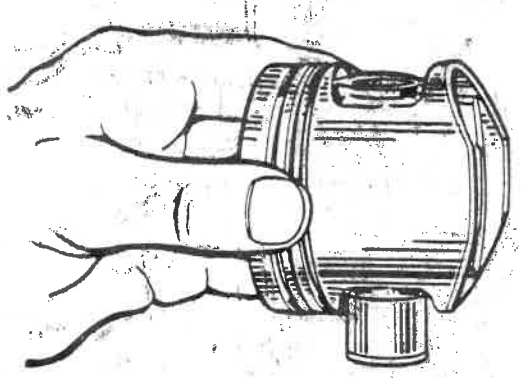

Fig.2-33. Checking Piston Pin Fit

The lower compression ring should be installed with the step down (Fig.2-30). If the ring bears mark BEPX or TOP install the ring with the mark facing up (towards the piston crown).

Prior to installing the oil control ring make sure that the joint of the expanding spring is arranged at the side opposite to the ring joint.

Condition Checks

Clean the piston from carbon and remove all deposits from the oil channels in the piston and connecting rod.

Inspect the parts thoroughly. Cracks of any character on the piston, piston rings, pin, connecting rod and its cap are not tolerable. If deep notches are seen on the working surface of the shells, replace the shells with new ones.

Side clearance between the piston rings and piston grooves should be checked with a set of feeler gauges as shown in Fig.2-34 by fitting the ring into the corresponding groove. The designed clearance (rounded off to 0.01 mm) for the new parts is 0.04 - 0.07 mm for the upper compression ring, 0.03 - 0.06 mm for the lower compression ring and 0.02 - 0.05 mm for the oil control ring. Maximum tolerable clearances caused by wear are 0.15 mm.

End clearance of the piston rings should be checked with a set of feeler gauges by fitting the ring into a gauge (Fig.2-35) with diameter of hole equal to ring nominal diameter with +0.007 mm tolerance. For rings with nominal diameter of 82 mm gauge 67,8125.9502 can be used.

The clearance should be within 0.25 and 0.45 mm for all rings.

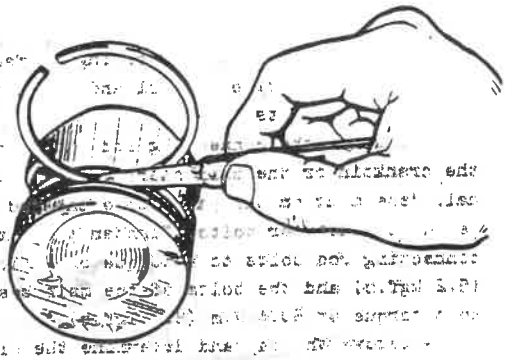

Fig.2-34. Checking Piston Ring Side Clearance

Fig.2-35. Checking Piston Ring End Clearance

CRANKSHAFT AND FLYWHEEL

Design Peculiarities

The main dimensions of the crankshaft are given in Fig.2-36.

Crankshaft - iron casting, five-bearing. A provision is made for regrinding the crankshaft journals and crankpins in repair with reduction of diameter by 0.25; 0.5; 0.75 and 1 mm.

Axial travel of the crankshaft is limited by two thrust half-rings. They are fitted in the seats of the cylinder block at both sides of the middle main bearing; a yellow cermet half-ring is installed at the rear and a steel-aluminium half-ring at the front. The half-rings of two sizes are available: normal and 0.127 mm oversize in thickness.

Shells of the crankshaft bearings are thin-walled, steel-aluminium. The upper shells of the Nos 1, 2, 4 and 5 bearings are provided with a groove on the inner surface and the lower shells have no groove. The shells of the 3rd bearing, both upper and lower, have no groove. The crankpin bearing shells (upper and lower) also have no groove.

Repair size shells of increased thickness are available to fit the crankshaft journals and crankpins of diameters reduced by 0.25, 0.5, 0.75 and 1 mm.

Flywheel - iron casting with press-fitted steel ring gear to start the engine by the starter. The flywheel is aligned by the front bearing of the gearbox clutch shaft press-fitted into the crankshaft end. On the rear plane of the flywheel near the ring gear a match mark in the form of a tapered recess is found. The match mark should be located opposite the crankpin of the No.4 cylinder.

Condition Checks and Repair

Crankshaft. Inspect the crankshaft. Cracks on the crankshaft are not tolerable. Scratches, nicks and notches on the surfaces mating with the gland active edges are not tolerable.

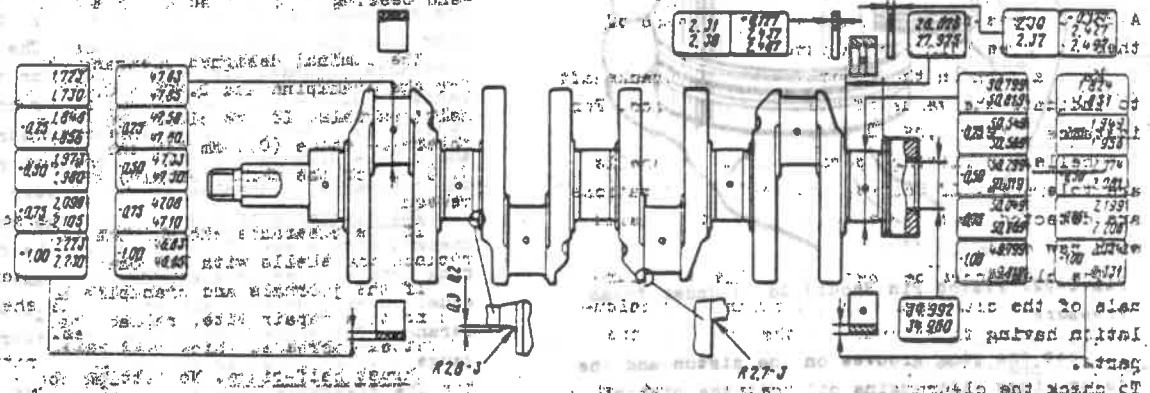

Fig.2-36. Main Dimensions of Crankshaft

Fit the crankshaft by its extreme main journals on two V-blocks (Fig.2-37) and using a dial indicator check runout:

- of the main journals which should not exceed 0.03 mm;
- of the seat surfaces for the sprocket and gearbox clutch shaft bearing which should not exceed 0.04 mm;
- of the surface mating with the gland which should not exceed 0.05 mm.

Check diameters of the main journals and crankpins. Grind them if wear exceeds 0.03 mm, out-of-roundness is greater than 0.03 mm and if scores and notches are seen on the journal and crankpin surfaces.

Grind the journals and crankpins to reduce diameter to the near repair size (Fig.2-36).

When grinding, do not change the sizes of the fillets which should be as indicated in Fig.2-36 for the crankshaft of the nominal size. Out-of-roundness and taper of the main journals and crankpins after grinding should not exceed 0.005 mm.

Displacement of the axes of the crankpins from the plane passing through the axes of the crankpin and main journals after grinding should be within ±0.35 mm (see Fig.2-37). To check install the shaft with its extreme main journals on the V-blocks and set it so that the axis of the No.1 cylinder crankpin should be in the horizontal plane passing through the axes of the main journals. Then, using a dial indicator, check displacement of the crankpins of the No.2, 3 and 4 cylinders relative to the crankpin of the No.1 cylinder.

Grind the journals and crankpins and polish them using diamond paste or paste GOI.

After grinding and subsequent finishing the journals and crankpins remove the pluge from the oil channels and run counterbore A.94016/10 fitted on spindle A.94016 through the plug sockets. Wash thoroughly the crankshaft and its channels to remove abrasive particles and blow them through with compressed air. Using driver A.86010 press-fit new pluge and stake each of them in three points by a punch.

Make a mark on the first web of the crankshaft to indicate the value of diameter reduction. For instance, I (MJ) 0.25; II (CP) 0.50 .

Shells. No fitting operations on the shells are tolerable. If scores, notches or separations are detected on the shells, replace the shells with new ones.

The clearances between the shells and journals of the crankshaft are determined by calculation having first measured the sizes of the parts.

To check the clearance a calibrated plastic wire can be used. In this case the method of checking is the following:

- thoroughly clean the working surfaces of the shells and respective journal and put a piece of plastic wire on its surface;
- install the connecting rod with its cap on the crankpin or the main bearing cap on the journal, depending on the part to be checked and tighten up the nuts or bolts. Tighten the nuts of the connecting rod bolts to a torque of 51 N.m (5.2 kgf.m) and the bolts of the main bearing caps to a torque of 80.4 N.m (8.2 kgf.m);
- remove the cap and determine the clearance by comparing the width of the flattened wire with the scale on the wire packing (Fig.2-38).

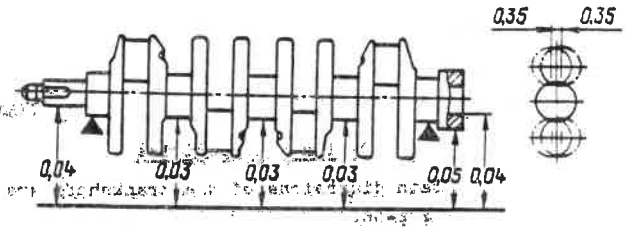

Fig.2-37. Permissible Runout of Crankshaft Basic Surfaces

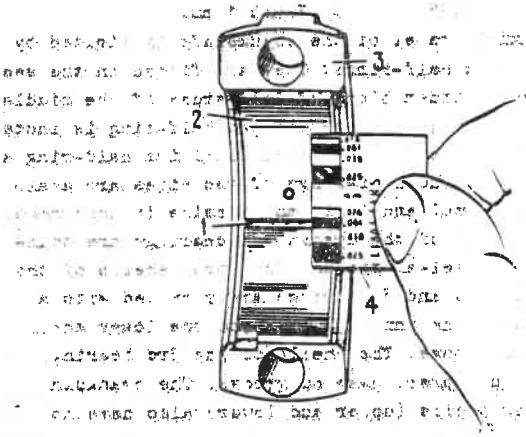

Fig.2-38. Checking Clearance in Crankpin Bearing: 1 - flattened calibrated wire; 2 - shell; 3 - big-end bearing cap; 4 - scale to measure clearance

The nominal designed clearance is 0.02 - 0.07 mm for the crankpins and 0.026 - 0.073 mm for the main journals. If the clearance is less than the tolerable value (0.1 mm for the crankpins and 0.15 mm for the main journals) the shells can be reused.

If the clearance exceeds the tolerable value, replace the shells with new ones.

If the journals and crankpins are worn and are ground to a repair size, replac the shells with oversized(increased thickness) ones.

Thrust half-rings. No fitting operations on the half-rings are tolerable. If scores, notches or separations are detected on the half-ring surfaces, replace the half-rings with new ones.

Replace the half-rings also if axial clearance of the crankshaft exceeds the maximum tolerable value of 0.35 mm. Select new half-rings of nominal thickness or 0.127 mm oversized to provide axial clearance within 0.06 and 0.26 mm.

Check axial clearance (end play) of the crankshaft by a dial indicator as described in Section 'Engine Assembly' and shown in Fig. 2-14.

The crankshaft axial clearance can be checked without removing the engine from the car. In this case axial displacement of the crankshaft is provided by pressing and releasing the clutch pedal, and the value of clearance is determined by the travel of the crankshaft front end.

Flywheel. Check condition of the ring gear and if its teeth are damaged, replace the flywheel.

Scratches and scores on surface 1 (Fig.2-39) of the flywheel mating with the crankshaft flange and on surface 3 for the clutch driven disc are not tolerable.

Scratches and scores should be removed from surface 3 by turning in a lathe, taking care not to remove more than 1 mm of metal. Also machine surface 2 providing size of (0.5±0.1) mm. When turning, provide parallel alignment of surfaces 2 and 3 relative to surface 1. Parallel misalignment should not exceed 0.1 mm.

Put the flywheel on a driver aligning it by the mounting hole with thrust against surface 1 and check runout of surfaces 2 and 3. In the extreme points the indicator should not read runout exceeding 0.1 mm.

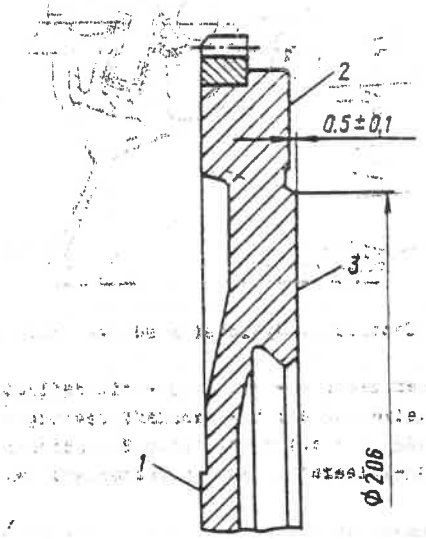

Fig.2-39. Flywheel:
1 - flywheel-to-crankshaft flange fastening surface; 2 - clutch mounting surface; 3 - clutch driven disc supporting surface

CYLINDER HEAD AND VALVE GEAR

Design Peculiarities

The main dimensions of the valves, guides and seats are given in Fig.2-40.

Cylinder head - aluminium casting with pressfitted cast iron seats and valve guides. The upper part of the guides is sealed by metal-rubber oil deflecting caps 3 (Fig.2-41).

Delivered for spare are guides with 0.2 mm oversized outer diameter.

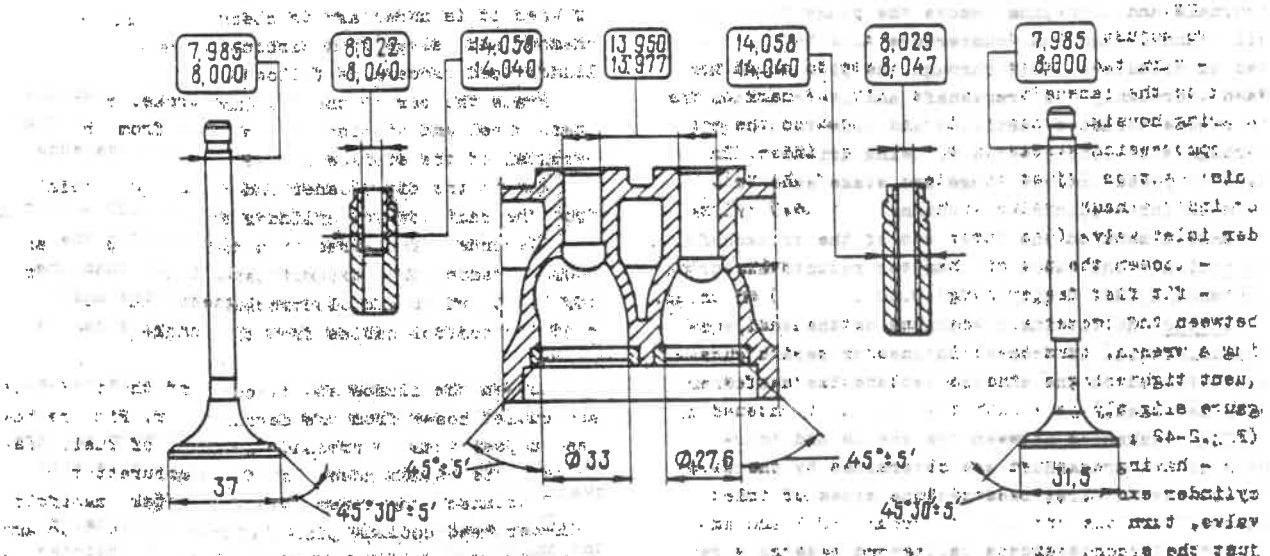

Fig.2-40. Basic Dimensions of Valves, Guides and Seats

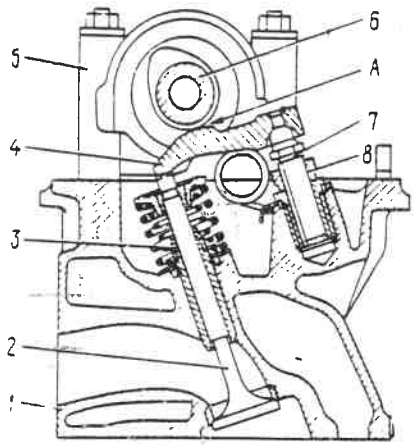

Fig.2-41. Section of Cylinder Head Over Exhaust Valve:
1 - cylinder head; 2 - valve; 3 - oil deflecting cap; 4 - valve rocker; 5 - camshaft bearing housing; 6 - camshaft; 7 - adjusting bolt; 8 - adjusting bolt locknut; A - clearance between rocker and camshaft cam

Secured on the cylinder head is bearing housing 5 which accommodates camshaft 6.

Valve gear. Valves 2 are actuated by camshaft cams through rockers 4. The rocker, with its one end, presses on the valve stem and with the other end rests on spherical head of adjusting bolt 7 by means of which clearance A in the valve gear is adjusted.

Adjusting Valve Gear Clearances

Adjust the clearances when the engine is cold having first adjusted the tension of the chain. After adjustment the clearance should be 0.14 - 0.17 mm.

To adjust proceed as follows:

- turn the crankshaft clockwise to align the mark on the camshaft sprocket with the mark on the bearing housing which will correspond to the end of compression stroke in the No.4 cylinder. In this position adjust the clearance of the No.4 cylinder exhaust valve (8th cam) and No.3 cylinder inlet valve (6th cam);
- loosen the nut of the rocker adjusting bolt;
- fit flat feeler gauge A.95111, 0.15 mm thick, between the rocker and the camshaft cam and, using a wrench, turn the bolt in or out with subsequent tightening of the locknut until the feeler gauge slightly jams with the locknut tightened up (Fig.2-42);
- having adjusted the clearances of the No.4 cylinder exhaust valve and No.3 cylinder inlet valve, turn the crankshaft through 180° and adjust the second pair of valves proceeding as stated in Table 2-2.

Table 2-2

Sequence of Valve Clearance Adjustment

Crankshaft degrees	End of compression stroke in cylinder No.	Adjusted valves (cams) No.
0	4	8 and 6
180°	2	4 and 7
360°	1	1 and 3
540°	3	5 and 2

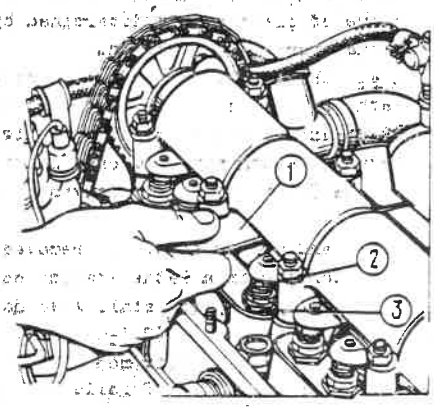

Fig.2-42. Checking Clearance Between Rockers and Camshaft Cams:
1 - feeler gauge A.95111; 2 - adjusting bolt; 3 - adjusting bolt locknut

Removal and Installation of Cylinder Head

The cylinder head can be removed from the engine mounted on the car if there is no necessity to remove the engine for elimination of a trouble or when it is necessary to clean the combustion chamber and valves from carbon. To remove the cylinder head proceed as follows:

Brake the car by the parking brake, remove the spare wheel and disconnect the wire from the 'minus' terminal of the storage battery.

Remove the air cleaner and drain the coolant from the radiator and cylinder block.

Disconnect the wires from the spark plugs and coolant temperature transmitter, from the carburettor limit switch and electromagnetic valve. Disconnect the control cables from the choke and throttle valves.

Loosen the clamps and disconnect the fuel inlet and outlet hoses from the carburettor. Fix the hoses in positions to preclude leakage of fuel. Disconnect the vacuum hose from the carburettor.

Disconnect the hoses from the intake manifold, cylinder head cooling jacket outlet connection and from the pipe delivering coolant to the heater. Remove the exhaust gas recirculation valve.

Disconnect from the exhaust manifold the starter shield, muffler inlet pipe and bracket of the heater coolant outlet pipe.

Remove the cylinder cover with gasket and fuel line bracket.

Turn the crankshaft to align the match mark on the camshaft sprocket with the mark on the bearing housing (Fig.2-22).

Turn out the bolt holding the camshaft sprocket. Back off the cap nut of the chain tensioner, using a tyre iron force off the tensioner rod and fix it in position by the cap nut. Remove the camshaft sprocket.

Turn out the bolts holding the cylinder head to the block and remove the cylinder head with the gasket.

Install the cylinder head in the reverse order observing the recommendations laid in Section 'Engine Assembly'. As the cylinder head gasket cannot be reused, install a new one.

When installing the cylinder head adjust tension of the chain and valve clearances in the valve gear. Having installed the cylinder head adjust the carburettor control linkage and ignition timing.

Disassembly and Assembly of Cylinder Head

Disassembly. If only one part is to be replaced, it is not necessary to completely disassemble the cylinder head. It can be sufficient to remove only the faulty parts.

Place the cylinder head on a support, disconnect the hose from the warm air intake, turn off the nuts and remove the carburettor with the gasket, then the intake and exhaust manifolds (simultaneously the warm air intake should be removed).

Remove the outlet connection of the cooling jacket and the branch to deliver coolant to the heater. Turn out the spark plugs and the coolant temperature transmitter.

Turn off the attachment nuts and remove the bearing housing complete with the camshaft. Turn off the nuts holding the thrust flange to the bearing housing. Remove the flange and take the camshaft out of the bearing housing.

Remove valve rockers 11 (Fig.2-43), releasing them from spring 12. Remove the rocker springs.

Back off locknuts 14 and turn out adjusting bolts 13 and adjusting bolt bushings 15.

Install tools A.60311/R as shown in Fig.2-44, compress the valve springs and release the locks. Stationary jig 02.7823.9505 can be used instead of portable tool A.60311/R.

Remove the valve springs with seats and retainers. Turn the cylinder head and take the valves from the bottom. Remove the oil deflecting caps from the guides.

Assembly. Assemble the cylinder head by reversing the disassembly procedure. Prior to assembly coat the valves and oil deflecting caps with engine oil.

Before installing the camshaft bearing housing make sure the locating bushings are in place (Fig.2-21). Tighten the bearing housing attachment nuts in the sequence indicated in Fig.2-23. Take care to prevent cocking of the locating bushings being fitted into the seats of the bearing housing.

Adjust the valve clearances after installation of the cylinder head on the engine.

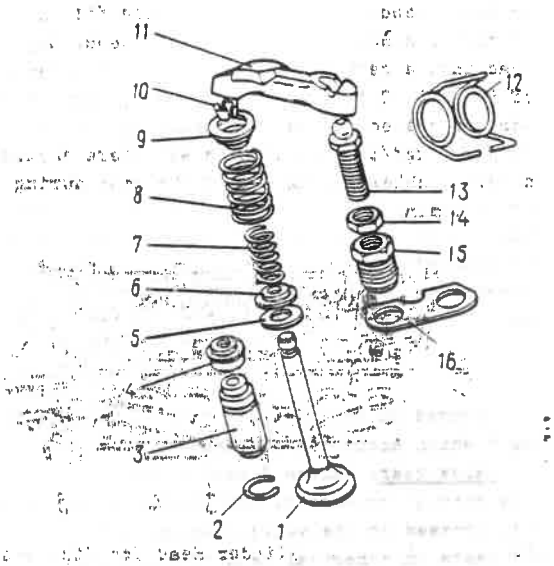

Fig.2-43. Valve Gear Parts:
1 - valve; 2 - locking ring; 3 - valve guide; 4 - oil-deflecting cap; 5 - outer spring seat; 6 - inner spring seat; 7 - inner spring; 8 - outer spring; 9 - spring retainer; 10 - locks; 11 - valve rocker; 12 - spring; 13 - adjusting bolt; 14 - adjusting bolt locknut; 15 - adjusting bolt bushing; 16 - rocker spring locking plate

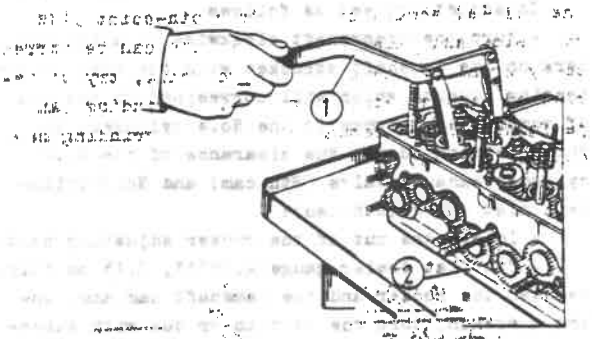

Fig.2-44. Removing Valve Springs:
1 - tool A.60311/R; 2 - support

Condition Checks and Repair

Cylinder Head. Thoroughly clean the cylinder head and clean the oil channels. Using a wire

brush clean the combustion chambers and exhaust valve surfaces from carbon.

Inspect the cylinder head. Cracks in any places of the cylinder head are not tolerable. If coolant gets into the oil, check the cylinder head for tightness. For this purpose stop the holes in the cylinder head cooling jacket with plugs of tool A.60334 (Fig.2-45). Using a pump deliver water at a pressure of 0.5 MPa (5 kgf/cm^2) into the cylinder head cooling jacket. There should be no water leakage from the cylinder head during 2 minutes.

Tightness of the cylinder head may be checked by compressed air; for this purpose fit the plugs of tester A.60334 on the cylinder head. Dip the head into a bath filled with water at a temperature of 60 - 80 °C and let it warm for 5 min. Then deliver compressed air at a pressure of 0.15 - 0.2 MPa (1.5 - 2 kgf/cm^2) into the head. There should be no air bubbles coming out of the head during 1 - 1.5 min.

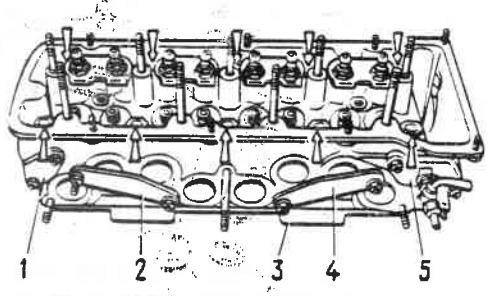

Fig.2-45. Checking Cylinder Head for Tightness on Tester A.60334:
1,2,4 - blank plugs; 3 - tester plate; 5 - flange and water inlet union

Valve Seats. The shape of the valve seat faces is illustrated in Figs 2-46 and 2-47.

The seat faces (in the zone of contact with the valves) should be free from pin-point pits, corrosion and damage. Minor defects can be corrected by grinding the seats. In so doing, try to remove as little metal as possible. Grinding can be performed either manually or with a grinding machine.

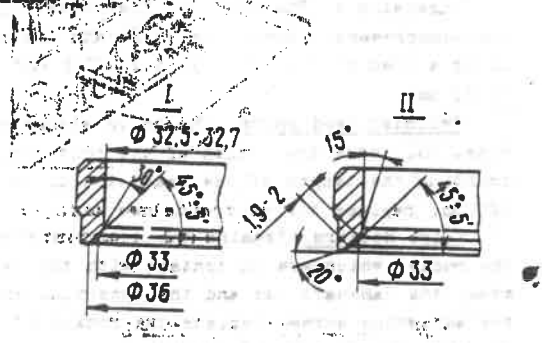

Fig.2-46. Inlet Valve Seat Contour:
I - new seat; II - refaced seat

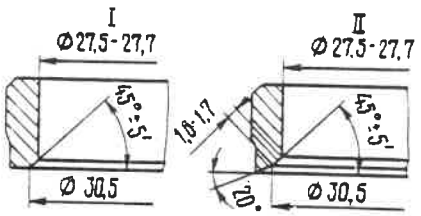

Fig.2-47. Exhaust Valve Seat Contour:
I - new seat; II - refaced seat

Grind the seats as follows:

Put the cylinder head on a support, insert spindle A.94059 into the valve guide and decarbonize the seat faces with counterbores A.94031, A.94092 exhaust valve seats and A.94003, A.94101 inlet valve seats. The counterbores should be secured on spindle A.94058 and aligned by pilot spindle A.94059. Spindles A.94059 are available in two different diameters: A.94059/1 for inlet valve guides and A.94059/2 for exhaust valve guides.

Put spring A.94069/5 on pilot spindle A.94059, install tapered wheel A.94078 (for exhaust valve seats) or wheel A.94100 (for inlet valve seats) on spindle A.94069, secure the spindle in the grinding machine and reface the valve seat (Fig.2-48).

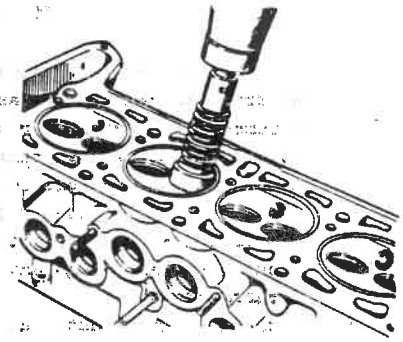

Fig.2-48. Valve Seat Refacing

At the moment of contact between the grinding wheel and the valve seat the machine should be turned off to avoid vibration which will distort the seat face.

It is recommended that the grinding wheel should be dressed frequently with diamond tools.

Bring the width of the working face on the exhaust valve seats to the values specified in Fig.2-46, using 20° counterbore A.94031 and counterbore A.94092 which removes the wear-hardened layer on the inside diameter. The counterbores should be slipped on spindle A.94058 and, like during the grinding, aligned by spindle A.94059.

Bring the width of the working face of the inlet valve seats to the values specified in Fig. 2-47, first machining the internal face by means of counterbore A.94003 (Fig.2-49) to obtain a diameter of 33 mm, then the 20° face by means of counterbore A.94101 until the width of the working face is 1.9-2 mm.

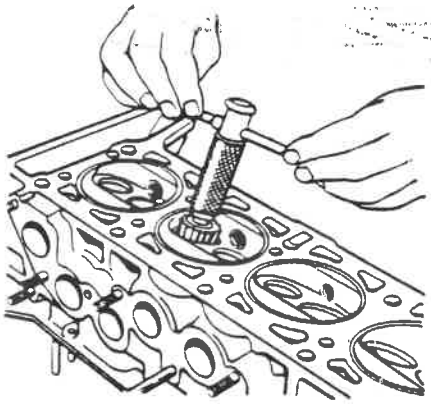

Fig.2-49. Chamfering Valve Seat Face with Counterbone Installed on Spindle A.94058

Valves. Remove carbon deposits from the valves. Check to see that the valve stem is not distorted and the valve plate is not cracked; replace the valve if it is damaged. Check the condition of the valve working face. Minor defects can be eliminated by grinding. Take care to provide face angle of 45°30'±5'. The distances from the lower plane of the valve plate to the reference diameters (36 and 30.5 mm) should be within the limits indicated in Fig.2-50.

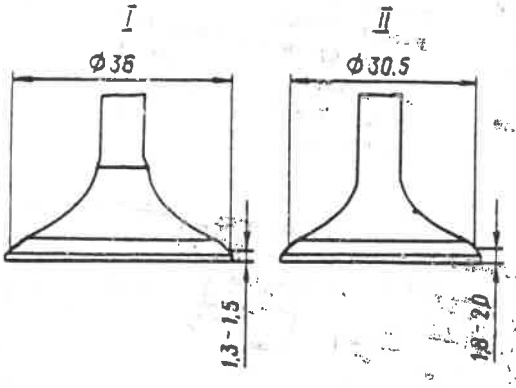

Fig.2-50. Tolerable Sizes in Valve Face Grinding: I - inlet valve; II - exhaust valve

Valve Guides. Check the clearance between the valve guides and the valve stem by measuring the diameter of the stem and the hole in the valve guide.

The assembly clearance for new guides is 0.022-0.055 mm (inlet valves) and 0.029-0.062 mm (exhaust valves). The maximum wear limit is 0.3 mm, provided no abnormal noise in the valve gear is heard.

If the guide-to-valve clearance is too big and cannot be eliminated by replacing the valve, replace the valve guides using mandrel A.60153/R (Fig.2-51) for pressing-out and press-fitting the valves.

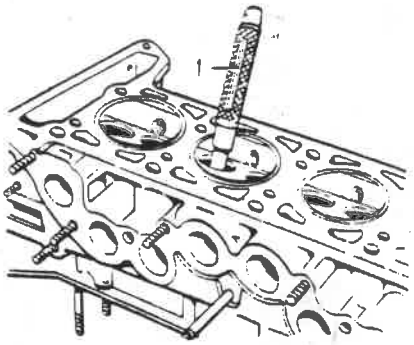

Fig.2-51. Pressing Out Bush Guides: 1 - mandrel A.60153/R

Drive in the valve guides complete with the locking ring until the latter comes to bear against the surface of the cylinder head.

Having pressed-in the guides, ream out their holes with reamers A.90310/1 (inlet valve guides) and A.90310/2 (exhaust valve guides).

Valve Guide Oil-Deflecting Caps. During engine repairs it is recommended that the caps should always be replaced by new ones.

Replace the damaged oil-deflecting caps, having removed the cylinder head. To press-fit a new cap use mandrel 41.7853.4016.

Valve Springs. Make sure that the springs are not cracked and have not lost their resilience. For this purpose, check them for deformation under load (Fig 2-52).

Dimension A (Fig.2-53) of the rocker springs (non-compressed) should be 35 mm and dimension B under a load of 51 - 73.5 N (5.2 - 7.5 kgf) should be 43 mm.

Cylinder Head Bolts. The bolts elongate in service. So, check the length of the bolt stem (not counting the length of the head) and if it exceeds 120 mm, replace the bolt with new one.

Valve Rockers. Examine the active surfaces of the rocker which are in contact with the valve stem, the camshaft cam and the spherical end of the adjusting screw. Replace the rocker if these surfaces are scored or notched.

If the rocker adjusting screw or its bushing is distorted or damaged, replace the parts.

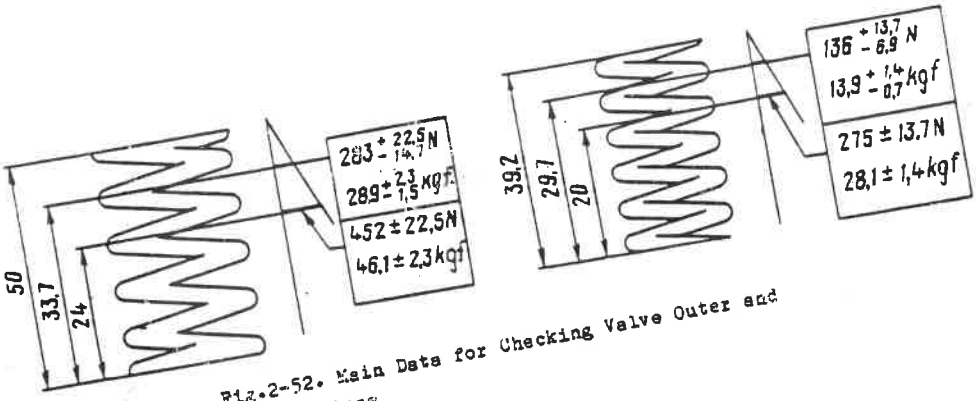

Fig.2-52. Main Data for Checking Valve Outer and Inner Springs
a - valve outer spring;
b - valve inner spring

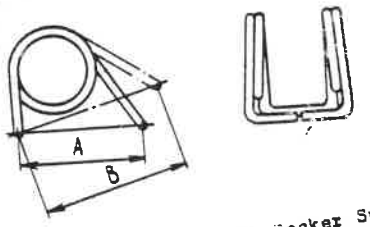

Fig.2-53. Checking Valve Rocker Spring:
A - free length; B - length under a load

CAMSHAFT AND DRIVE

Design Peculiarities

Camshaft. Cast iron camshaft rests by five journals on bearings in an aluminium bearing housing installed on the cylinder head. Main dimensions of the camshaft and bearing housing are given in Fig.2-54. The surfaces of the cams are chilled to increase wear resistance. The camshaft is held from axial displacement by a thrust flange in the recess on the front journal of the camshaft.

Camshaft Drive. The camshaft is driven by two-row roller chain 2 (Fig.2-55) from driving sprocket 5. The same chain is used to drive sprocket 4 of the oil pump. The chain drive has semi-automatic tensioner 8 with shoe 7 and chain damper 3 with rubber pieces.

Found in the lower part of the cylinder block is limiting pin 6 which prevents slipping of the chain into the crankcase when camshaft sprocket 1 is removed from the shaft on the car.

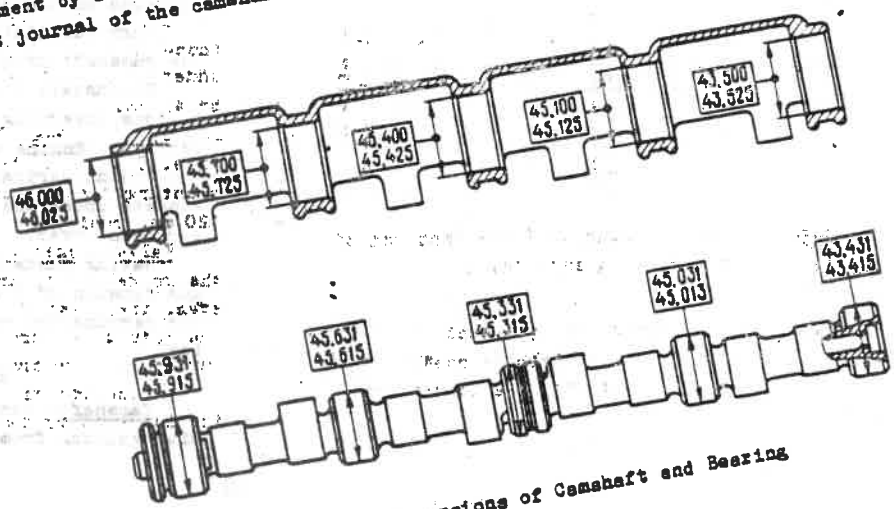

Fig.2-54. Main Dimensions of Camshaft and Bearing Housing

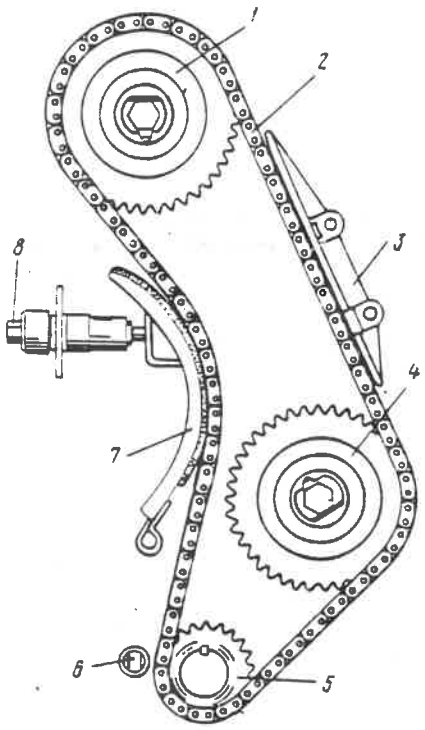

Fig.2-55. Camshaft and Accessory Drive Diagram:
1 - camshaft sprocket; 2 - chain; 3 - chain damper; 4 - oil pump drive shaft sprocket; 5 - crankshaft sprocket; 6 - limiting pin; 7 - tensioner shoe; 8 - chain tensioner

Adjusting Chain Tension

Loosen tensioner nut 1 (Fig.2-56). This will release spindle 3, and the chain will be tensioned by shoe 7 (Fig.2-55) which is acted upon by spring 7 (Fig.2-56).

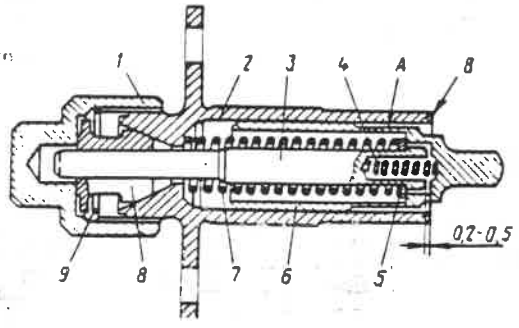

Fig.2-56. Chain Tensioner Section:
1 - cap nut; 2 - tensioner body; 3 - spindle; 4 - plunger spring; 5 - washer; 6 - plunger; 7 - spring; 8 - retainer; 9 - spring ring
A - plunger surface;
B - points of staking

Turn the crankshaft 1-1.5 revolutions in the normal direction. The tensioner spring which actuates the shoe will automatically set the proper chain tension.

Tighten tensioner nut 1; as a result, spindle 3 will be clamped by the collets of retainer 8 so that, on the running engine, plunger 6 will be loaded by spring 4 alone. This spring forces the plunger off the head of spindle 3, and the clearance between them is filled with oil on the running engine, this oil functioning as a shock-absorbing medium during chain impacts.

Replacing Chain

To remove the chain apply the parking brake, open the hood, remove the spare wheel with the supporting tube and remove the storage battery.

Remove the air cleaner and stop the carburettor inlet neck with a dummy plug. Disconnect the choke and throttle valve control cables from the carburettor.

Drain coolant from the radiator and cylinder block, remove the radiator with the hoses and thermostat. Remove the fan having turned off the attachment nuts.

Remove the cylinder head cover and turn the crankshaft to align the mark on the camshaft sprocket with the mark on the bearing housing (Fig.2-21) and the mark on the alternator drive pulley with the long mark on the camshaft drive cover (Fig.7-18).

Turn out the bolt holding the camshaft sprocket. Loosen the cap nut of the chain tensioner; using a tyre iron force off the tensioner spindle and lock it by the cap nut. Remove the camshaft sprocket.

Loosen the alternator fasteners and remove its drive belt. Shift in the 4th gear in the gearbox, turn out the jaws and remove the alternator drive pulley from the crankshaft.

Remove the camshaft drive cover with the gasket having turned off the nuts holding the cover to the cylinder block and the bolts holding the oil pump to the cover.

Turn out limiting pin 6 (Fig.2-55) and remove the camshaft drive chain.

To install the chain reverse the removal operations observing the recommendations laid in Section "Engine Assembly". Prior to installing the chain lubricate it with engine oil. Fit new gaskets under the camshaft drive cover and cylinder head cover.

Having installed the chain adjust its tension and tension of the alternator drive belt, adjust the carburettor control linkage and ignition timing.

Condition Checks

Camshaft. Scores, nicks, scratches and aluminium galling from the bearing housings are not ta-

lerable on the camshaft journals. Wear exceeding 0.5 mm on the working surfaces of the cams, and scores and facing are not tolerable.

Put the camshaft with its extreme journals on two V-blocks placed on a surface plate and check radial runout of the middle journals with an indicator. The runout should not exceed 0.04 mm, otherwise the camshaft should be trued up in a straightening press.

Camshaft Bearing Housing. Wash and clean the camshaft bearing housing and the oil channels.

Check the diameter of holes in the supports. If the clearance between the camshaft journals and supports exceeds the 0.2 mm (maximum tolerable wear), the bearing housing should be replaced.

The internal supporting surfaces should be smooth and free of scores. Replace the housing if these surfaces are damaged.

Examine the housing for cracks and replace it, if cracked.

Chain tensioner. If the plunger of the tensioner seizes in the body, disassemble the chain tensioner. For this purpose turn off locking cap nut 1 (Fig.2-56), push in plunger 6 as far as it will go and tighten up the cap nut. Then, pressing on the plunger, file off the edges of the holes in the body in staking points B and take out plunger 6 with spring 4. Then turn off the cap nut and take spindle 3 complete with spring 7 and washer 5. Remove spring ring 9 and take retainer 8 out of cap nut 1.

Check retainer 8, spindle 3 and plunger 6 for scores and the mating surfaces of the shoe and tensioner plunger for deep notches. Replace defective parts.

Resilience of the tensioner spring should be within the limits indicated in Fig.2-57; if the resilience is less than specified, replace the spring.

Check the shoe and damper for heavy wear; replace them, if worn.

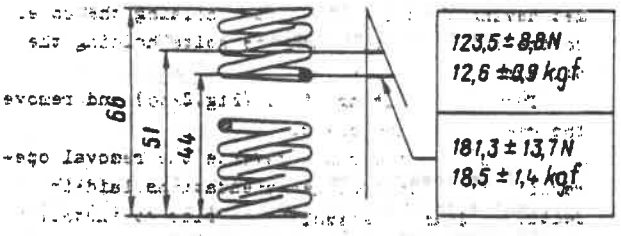

Fig.2-57. Main Data for Checking Tensioner Spring

To assemble the tensioner reverse the disassembly operations. Having installed the plunger stake body 2 in three points B. See that projections in the staked points do not come in touch with surface A when the plunger travels.

Camshaft drive chain. Wash the chain in kerosene and examine its links. The rollers and sideplates should be free of chipping, cracks and other kinds of damage.

The chain is apt to become stretched in service. It is considered serviceable if the tensioner is capable of ensuring its adequate tension, i.e. when the chain is elongated by not more than 4 mm.

Check the stretching of the chain on device 67.7824.9521 equipped with two stepped rollers 1 (Fig.2-58) for installing the chain. By means of counterweight 3 the chain is stretched with a force of 294 N (30 kgf) or 147 N (15 kgf). Adjusting nut 2 ensures that the counterweight axis is parallel to the base of this device.

Stretch the chain with a force of 294 N (30 kgf) by putting the counterweight in its extreme right end position, then slacken it to 147 N (15 kgf), having shifted the counterweight to its extreme left end position. Repeat both operations and measure distance L (Fig.2-59) between the roller axes. Having measured the distance between diameters d of rollers and added thereto diameter d, you will get distance L between the roller axes.

For a new chain distance L between the roller axes is 495.4–495.8 mm. Replace the chain if it is stretched to 499.5 mm.

Before installing the chain on the engine, coat it with engine oil.

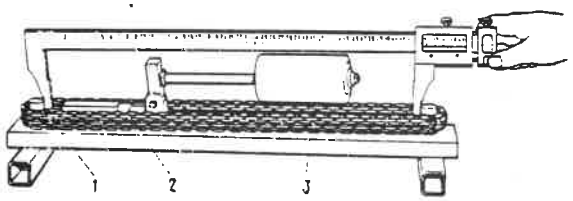

Fig.2-58. Device 67.7824.9521 for Checking Wear (Stretching) of Chain:
1 – roller; 2 – adjusting nut; 3 – counterweight

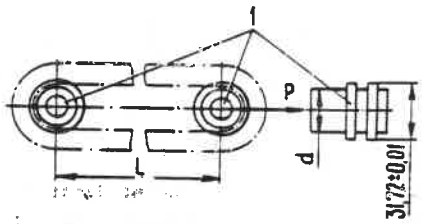

Fig.2-59. Chain Wear (Stretching) Check Diagram:
1 – rollers

A diagram of the cooling system is shown in Fig.2-60.

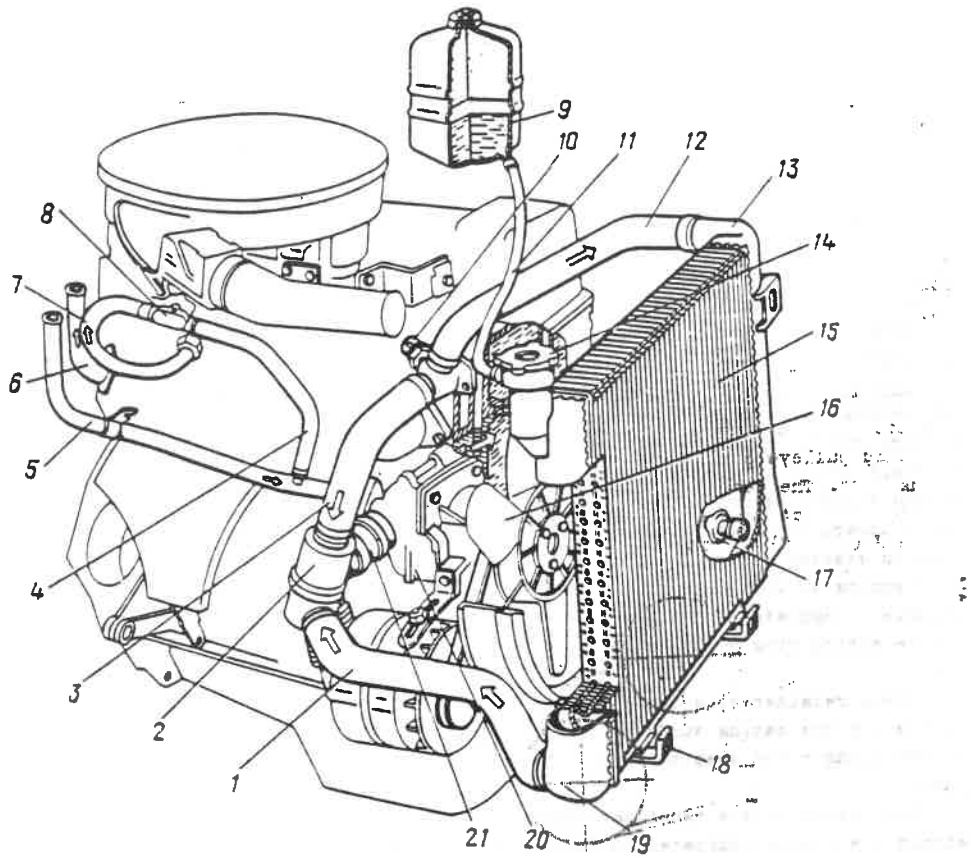

Fig.2-60. Engine Cooling System:
1 - radiator outlet hose; 2 - thermostat;
3 - thermostat bypass hose; 4 - hose to pass coolant to pump; 5 - body heater radiator outlet pipe;
6 - body heater radiator inlet connection;
7 - hose to pass liquid from intake manifold heating unit to carburettor heating unit;
8 - carburettor heating unit; 9 - expansion tank;
10 - coolant temperature transmitter; 11 - hose from radiator to expansion tank; 12 - radiator inlet hose; 13 - radiator L.H. tank; 14 - radiator cap; 15 - radiator core; 16 - radiator fan; 17 - drain plug; 18 - radiator support rubber pa::
19 - radiator R.H. tank; 20 - coolant pump;
21 - hose to deliver coolant to pump

Checking Coolant Level and Specific Gravity

The quantity of coolant in the cooling system is checked by the liquid level in the expansion tank. On a cold engine (15 - 20 °C) the level should be 3 - 4 cm above the "MIN" mark on the expansion tank.

Caution:

It is good practice to check the coolant level on a cold engine since the volume of heated coolant increases so that its level on a hot engine may rise considerably.

If necessary, check the specific gravity of coolant with a hydrometer. It should be 1.078-1.085 g/cm^3 for Toyota A-40 liquid.

If the coolant level in the expansion tank is lower than prescribed and its specific gravity is too high, add some distilled water. If the specific gravity is normal, add some coolant of the grade contained in the system.

If the specific gravity of the coolant is lower than prescribed for the cold season, take care to replace it with a proper grade.

Filling Cooling System

As a rule, the cooling system is filled either when the coolant has to be changed, or after engine repairs. To fill the system:

- remove the radiator and expansion tank caps and open the heater cock;
- pour 10.7 l of coolant into the radiator; keep pouring until the liquid starts flowing from the radiator throat; then replace the radiator cap;
- pour the remaining coolant into the expansion tank and put in place its cap;
- run the engine idle for 1 - 2 min to remove any air pockets.

Allow the engine to cool down and recheck the coolant level. If it drops below the prescribed mark and there are no leaks in the system, top up the system.

Adjusting Pump Drive Belt Tension

The tension of the belt should be checked by measuring its deflection between the alternator and pump pulleys or between those of the pump and crankshaft. The tension is considered correct when deflection A of the belt (Fig.2-61) under a force of 98 N (10 kgf) is within 12 - 17 mm.

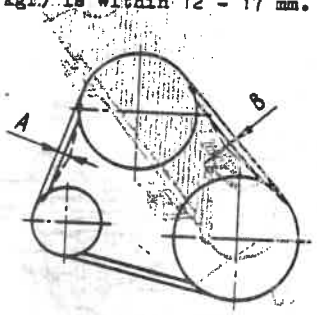

Fig.2-61. Checking Pump Drive Belt Tension

To tension the belt, loosen the alternator fastening nuts, push the alternator away from the engine and retighten the nuts.

Coolant Pump

Disassembly. To disassemble the pump:

- detach pump body 5 (Fig.2-62) from cover 3;
- secure the cover in a vice, using gaskets, and take impeller 2 (Fig.2-63) from the shaft with remover A.40026;
- remove hub 2 (Fig.2-64) of the fan pulley from the shaft with remover A.40005/1/5;
- turn out lock screw 8 (Fig.2-62) and take out the bearing with the pump shaft;
- pull gland 7 out of body cover 3.

Inspection. Check the end play of the bearing. This operation is mandatory when the pump was very noisy in operation. The clearance should not exceed 0.13 mm under a load of 49 N (5 kgf). Replace the bearing with the shaft if the clearance is larger.

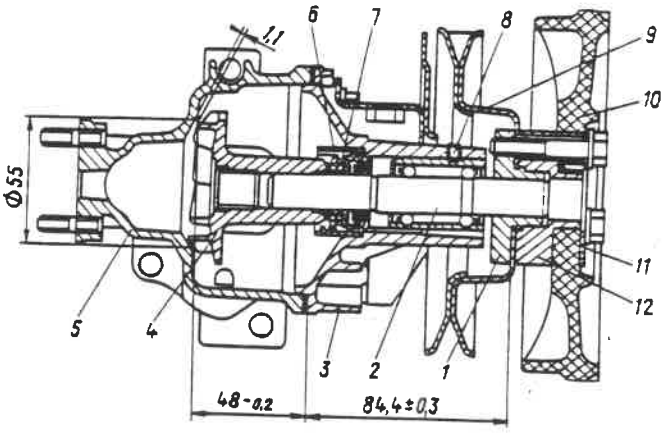

Fig.2-62. Coolant Pump Longitudinal Section:
1 - pulley hub; 2 - shaft; 3 - cover; 4 - impeller; 5 - body; 6 - thrust ring; 7 - gland; 8 - bearing lock screw; 9 - pulley; 10 - fan; 11 - cover plate; 12 - fan hub

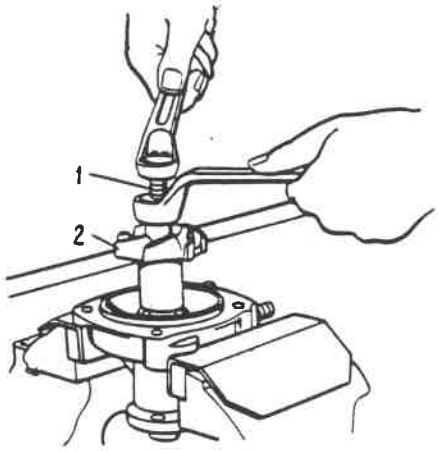

Fig. 2-63. Removing Pump Impeller:
1 - remover tool; 2 - impeller

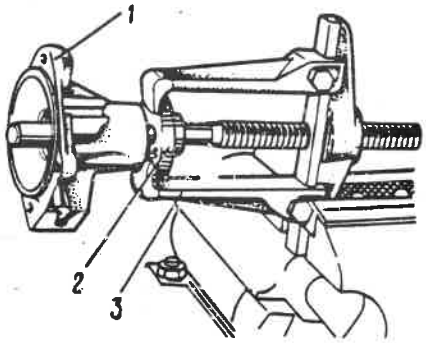

Fig.2-64. Removing Pulley Hub:
1 - pump body cover; 2 - pulley hub; 3 - remover A.40005/1/5

It is good practice to replace the pump gland and the pump-to-cylinder block gasket during repairs.

Examine the pump body and cover: there should be no distortions and cracks.

Assembly. To assemble the pump:

- using a mandrel, install the gland into the body cover without cocking;
- drive in the bearing with the shaft into the cover so that the lock screw socket is in line with the hole in the pump body cover;
- turn in the bearing lock screw and lock-punch the socket along the contour to prevent the screw from working loose;
- using tool A.60430 (Fig.2-65) force the pulley hub on the shaft, ensuring a dimension (84.4 ± 0.3) mm. If the hub is made of ceramet, only a new hub should be pressed on;
- press-fit the impeller on the shaft with tool A.60430, ensuring a clearance of $48_{-0.2}$ mm shown in Fig.2-62. This will provide a required clearance between the impeller blades and the pump body;
- assemble the pump body with the cover, installing the gasket in between.

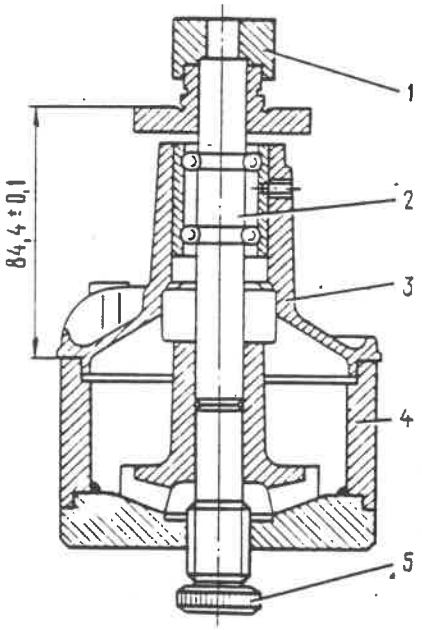

Fig.2-65. Pressing Impeller on Pump Shaft with Tool A.60430:
1 - support; 2 - pump shaft; 3 - pump body cover; 4 - sleeve; 5 - setting screw

Thermostat

Check the temperature at which the thermostat main valve starts opening and measure the travel of the valve.

For this purpose, place the thermostat on a EC-106-000 stand, immersing it into a tank with water or coolant. Touch the indicator rod bracket against the bottom of main valve 9 (Fig.2-66).

The initial temperature of the liquid in the tank should be 73-75 °C. Raise the liquid temperature gradually at a rate of approximately 1 °C per minute, stirring the liquid constantly so as to obtain uniform temperature throughout its volume.

The temperature at which the valve starts opening is the temperature at which the travel of the main valve reaches 0.1 mm.

Replace the thermostat if the temperature when the main valve begins to open is other than (80 ± 2) °C or if travel of the main valve is less than 6.0 mm. For the thermostats of Poland make the opening temperature is (83 ± 2) °C.

The simplest check of the thermostat can be made directly on the car. Having started a cold engine, hand-feel the radiator; if the thermostat is in order, the bottom tank of the radiator should start getting warmer when the pointer of the coolant temperature gauge is about 3-4 mm from the red zone on the scale, which corresponds to 80 - 85 °C.

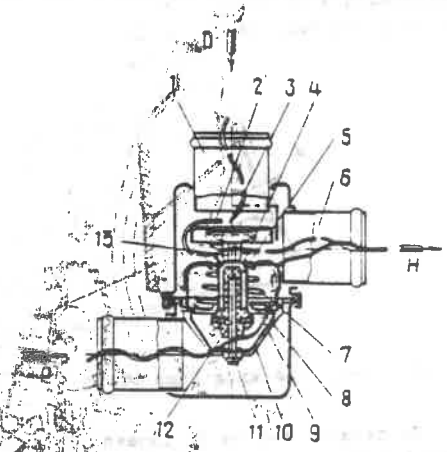

Fig.2-66. Thermostat:
1 - inlet connection (from engine); 2 - bypass valve; 3 - bypass valve spring; 4 - sleeve; 5 - rubber insert; 6 - outlet connection; 7 - main valve spring; 8 - main valve seat; 9 - main valve; 10 - holder; 11 - adjusting nut; 12 - piston; 15 - case; D - coolant from engine; P - coolant from radiator; H - coolant to pump

Radiator

Removal from Car. To remove the radiator from the car:

- take away the spare wheel and remove its supporting tube;
- drain the radiator and the cylinder block by removing the drain plugs from the radiator bottom tank and the cylinder block; open the heater cock and remove the radiator filler cap;
- disconnect the coolant hoses from the radiator;

- remove the fan shroud, first separating its halves;

- turn out two bolts holding the radiator to the body, force off the upper latch of the radiator guide casing upwards, move the radiator upwards towards the engine and take it out of the engine compartment;

- take out the radiator guide casing.

Tightness Test. The radiator can be checked for tightness in a water bath.

Plug the radiator connections, feed in air at a pressure of 0.2 MPa (2 kgf/cm^2) and dip the radiator into the water bath for at least 30 s. There should be no air bubbles.

If the radiator is damaged or leaky repair it or replace with a new one.

Repair of Radiator. If the aluminium tubes are damaged, disassemble the radiator, drill out the defective tubes at both sides with a 8.5 mm dia drill to a depth of 25 - 30 mm. Fit repair tubes, bore 7.3 mm and wall thickness 0.5 mm, flared at one end, into the defective tubes. Then force a steel mandrel, diameter $7.5^{+0.05}$ mm through the tubes over their entire length on a special stand.

Expand the repair tubes at both ends each on an expanding stand.

Assemble the radiator and check it for tightness.

LUBRICATING SYSTEM

The design of the lubricating system is shown in Fig.2-67.

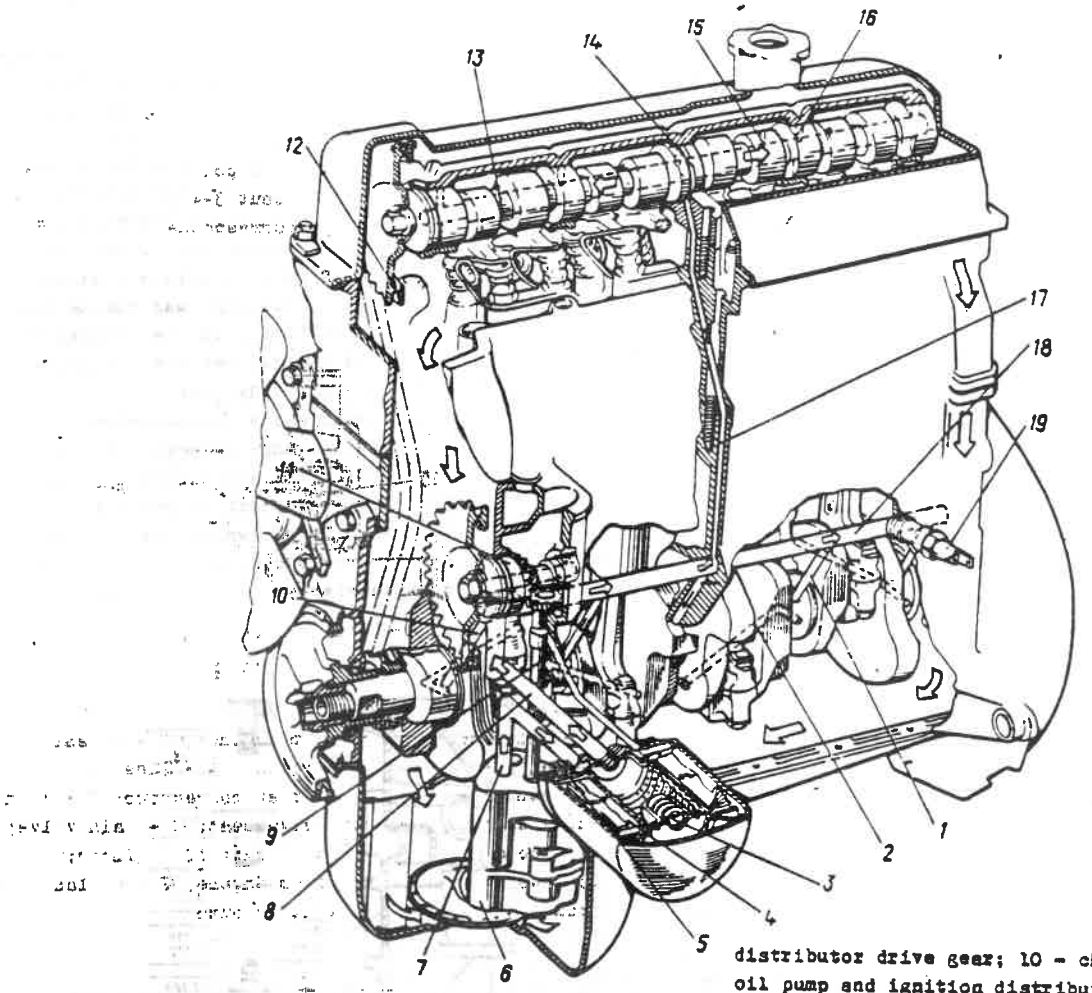

Fig.2-67. Lubricating System:
1 - channel to feed oil to main bearing; 2 - channel to feed oil from main bearing to crankpin bearing; 3 - oil pump by-pass valve; 4 - paper filter element; 5 - antidrain valve; 6 - oil pump; 7 - channel to feed oil from pump to filter; 8 - channel to feed oil from filter to main oil line; 9 - channel to feed oil to pump and ignition distributor drive gear; 10 - channel to feed oil to oil pump and ignition distributor drive shaft; 11 - oil pump and ignition distributor drive shaft; 12 - channel in driven sprocket to feed oil to chain; 13 - camshaft; 14 - circular groove in middle journal of camshaft; 15 - channel in camshaft cam; 16 - channel in camshaft journal; 17 - vertical channel in cylinder block to feed oil to valve gear; 18 - main oil line; 19 - electric oil pressure warning lamp transmitter

Changing Oil

Change the oil while the engine is still hot. Wait at least 10 min after opening the drain hole to provide for complete drainage of oil.

When replacing the oil be sure to replace the oil filter too. It can be removed with the aid of remover A.60312 (Fig.2-4). Install the filter by screwing it in hand-tight.

Change the oil in the following order:

- stop the engine, drain the used oil and, without removing the oil filter, pour in detergent oil ВНИИНП-ФД,МСП-1 or МТТ-2М to the "MIN" mark on the oil dipstick (2.9 l);
- start the engine and run it at the minimum idle speed for 10 min;
- drain all detergent oil and remove the old oil filter;
- install a new oil filter and pour in fresh lubricating oil of the grade suited to the season.

Oil Pump

The main dimensions of the oil pump and its drive are given in Fig.2-68.

Removal and Installation. If the oil pump alone has to be repaired, remove the engine from the car (see "Engine Removal and Installation"), mount it on a turnover stand, drain oil from the engine sump, turn over the engine and remove the oil sump. Then unscrew the oil pump fastening bolts and take off the pump complete with the intake connection.

To install the pump, reverse the removal operations.

Disassembly and Assembly. Clamp the pump in a vice taking care not to damage the body and do the following:

- unscrew the bolts and remove the intake connection complete with the oil pressure reducing valve;
- remove pump body cover 3 (Fig.2-69) and take the pump shaft with the drive gear, then the driven gear, out of the body.

To assemble, clamp the pump cautiously in a vice and proceed as follows:

- install the drive gear with the shaft into the pump body and slip the driven gear on the axle in the body;
- install the body cover, the reducing valve with the spring and fasten the intake connection to the pump body.

Note. The gears in the assembled pump should rotate smoothly and without jamming when the drive shaft is being turned by hand.

Checking Pump Parts. Wash all parts of the disassembled pump in kerosene or gasoline and blow them with compressed air; then examine the pump body and cover; replace any cracked parts.

Using a set of feeler gauges check the clearances between the gear teeth, also between the gear tips (outside diameters of the gears) and the pump body walls (Fig.2-70) which should be, respectively, 0.15 mm (maximum permissible clearance being 0.25 mm) and 0.11 - 0.18 mm (maximum permissible clearance being 0.25 mm). If the clearances exceed the permissible limits, replace the gears or, if necessary, the pump body too.

Using a feeler gauge and a straightedge (Fig.2-71) check the clearance between the gear faces and the surface of the body; this clearance should be 0.066 - 0.161 mm (maximum permissible 0.2 mm). If the clearance is larger than 0.2 mm, replace the gears or the pump body, depending on whichever is worn heavier.

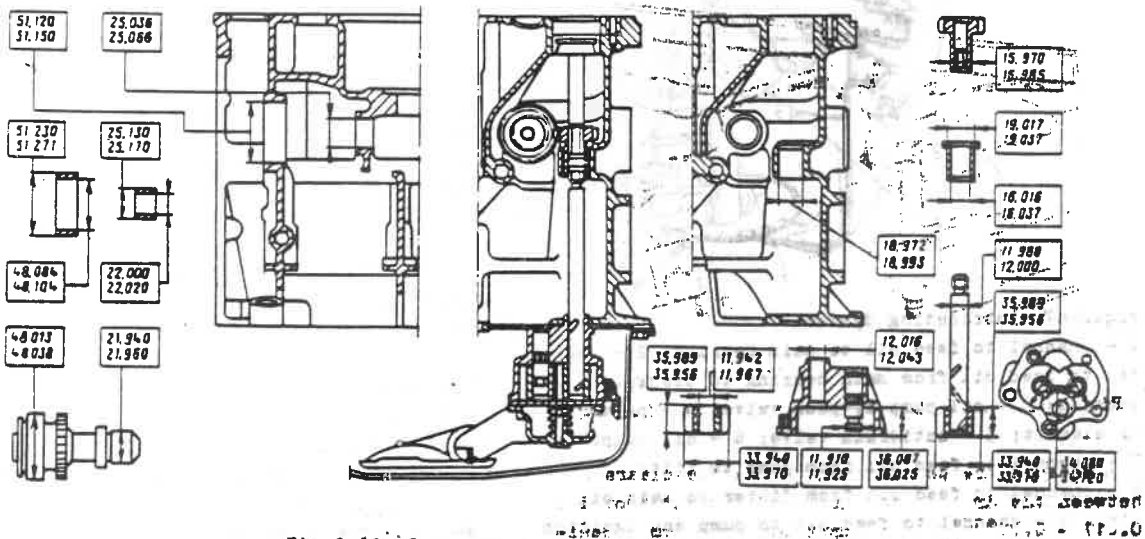

Fig.2-68. Basic Dimensions of Oil Pump and Drive

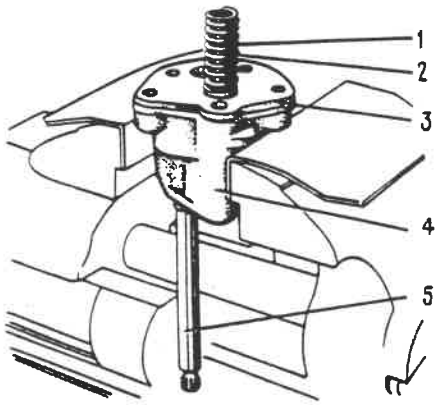

Fig.2-69. Disassembling Oil Pump:
1 - reducing valve; 2 - valve spring; 3 - cover; 4 - body; 5 - shaft

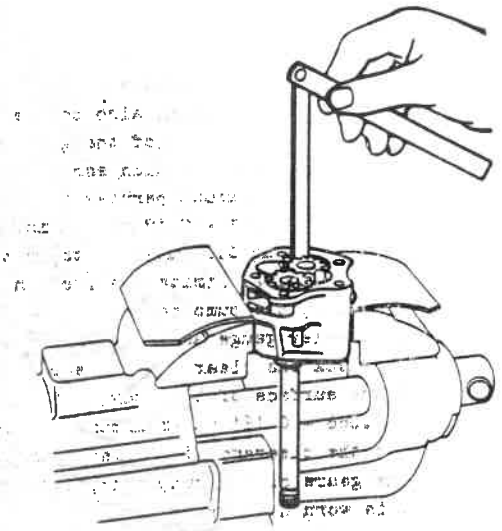

Fig.2-70. Checking Radial Clearance in Oil Pump

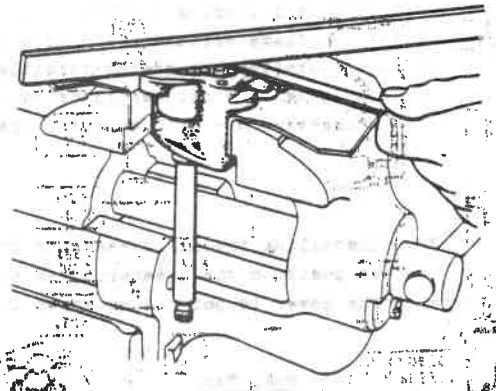

Fig.2-71. Checking Axial Clearance in Oil Pump

Measure the parts to determine the clearance between the driven gear and its axle. It should be 0.017 - 0.057 mm (wear limit being 0.1 mm). Besides, measure the clearance between the pump shaft and the bore in the body. This clearance should be 0.016 - 0.055 mm (maximum permissible clearance being 0.1 mm). If the clearances exceed the limits, replace the worn parts.

Checking Reducing Valve. When repairing the oil pump, take care to examine the reducing valve. Pay attention to the condition of the valve and body surfaces since dirt or deposits on the mating surfaces may cause jamming. The mating surfaces of the valve should be free of nicks and burrs which may decrease pressure in the system.

Check the valve spring for resilience against the data given in Fig.2-72.

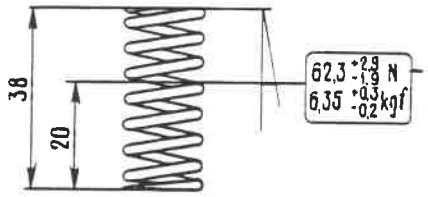

Fig.2-72. Basic Data for Checking Reducing Valve Spring

Oil Pump Drive Shaft and Gears

The shaft journals and the active surface of the eccentric should be free of dents and notches.

The teeth of the oil pump and ignition distributor drive gears should not be chipped; otherwise, replace the defective shaft and the gears.

Oil Pump Drive Shaft Bushes. Check the inside diameter of the bushes, their fit in the bores and alignment of the oil hole in the front bush with the channel in the cylinder block (turning of the bush). The inside surface of the bushes should be smooth and free of scores.

Measure the diameters of the shaft and bushes and determine the clearances between the bushes and the bearing surfaces of the shaft. If the clearance exceeds the 0.15 mm wear limit, also if the bushes are damaged on the surface or loose in the bores, replace them by new ones.

Both installation and removal of the bushes should be performed with driver A.60333/1/2 (Fig.2-73), observing the following requirements:

- the bushes must be press-fitted into their bores so that the oil hole in the front bush is lined up with the lubrication channel in the cylinder block;
- after press-fitting, the bushes must be finished to the exact inside diameter (for dimensions see Fig.2-68). To ensure perfect axial alignment of the shaft bushes, ream both of them jointly with the aid of reamer A.90353.

Oil Pump Drive Gear Bush. Check the bush for reliable press-fitting in the bore. Replace the bush if its inside surface is rough and scored.

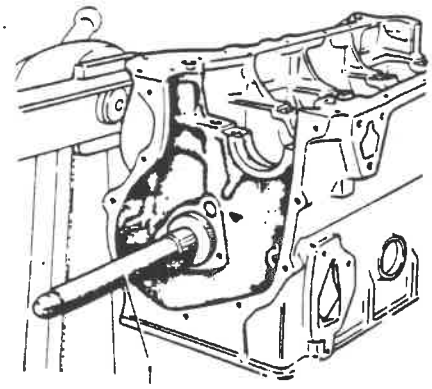

Fig.2-73.Removal and Installation of Oil Pump and Ignition Distributor Drive Shaft Bushes:
1 - driver A.60333/1/2

To force the bush in or out, use driver A.60326/R (Fig.2-74).

After press-fitting, ream out the bush to 16.016 - 16.037 mm.

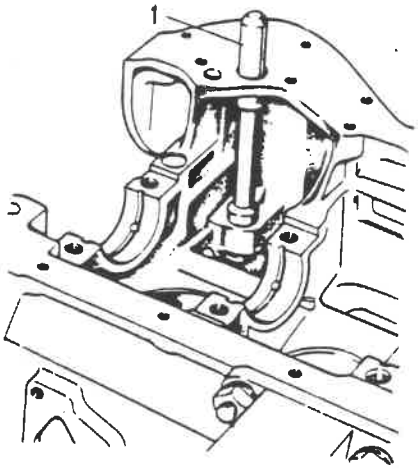

Fig.2-74. Pressing Out Oil Pump and Ignition Distributor Drive Gear Bush:
1 - driver A.60326/R

Crankcase Breathing System

Washing. To wash the system, disconnect breathing hoses 4 and 8 (Fig.2-75) from the connections, take flame arrester 3 out of hose 5, remove cover 6 of oil separator 7 and wash them with gasoline or kerosene.

It is necessary also to wash and blow through with compressed air the carburettor connection used to draw out crankcase fumes into the carburettor behind-the-throttle space.

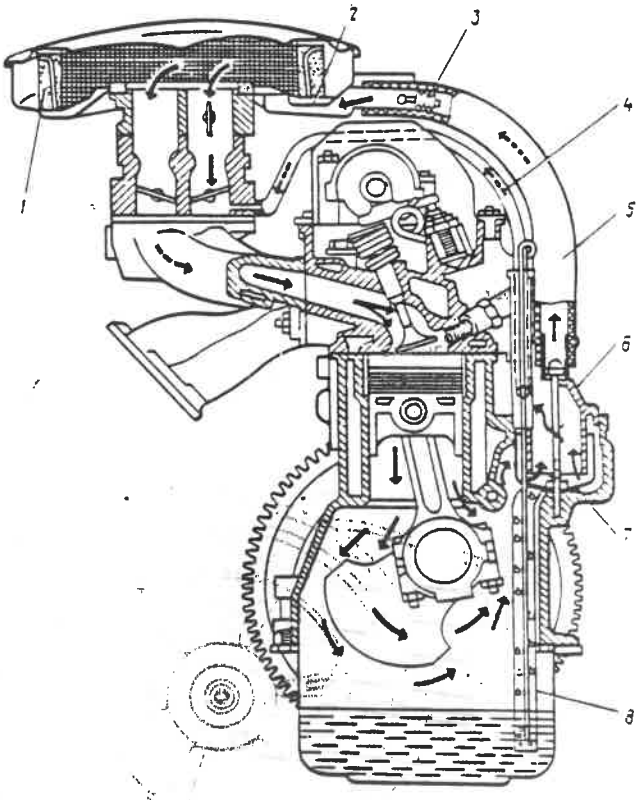

Fig.2-75. Crankcase Breathing System:
1 - air cleaner filtering element; 2 - drawout manifold; 3 - flame arrester; 4 - hose to deliver gases to carburettor behind-the-throttle space; 5 - drawout hose; 6 - oil separator cover; 7 - oil separator; 8 - oil separator drain pipe

FUEL SYSTEM

Air Cleaner and Temperature Controller

Removal and Installation. To remove the air cleaner force off spring clips 14 (Fig.2-76) and turn off nut 7 holding air cleaner cover 8. Remove the cover and take out filtering element 10.

Turn off the nuts holding housing 13 to the carburettor. Remove the cleaner housing complete with temperature controller 5 having first disconnected corrugated hose 2.

Back off clamping bolt 6 and remove temperature controller 5 with cold air intake 4.

When installing the air cleaner to reduce intake noises position the cleaner cover so that the arrow on the cover is pointed as shown in Fig.2-77.

Fuel Tank

Removal and Installation. To remove fuel tank 1 (Fig.2-78) from the car disconnect the ground wire from the storage battery.

Unscrew cap 5 of filler pipe 4 and drain gasoline, as much as possible.

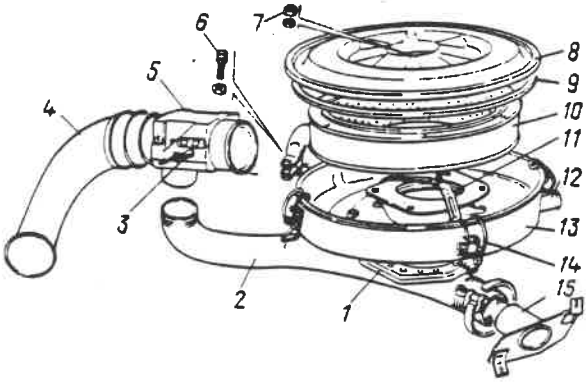

Fig.2-76. Air Cleaner and Temperature Controller: 1 - sealing gasket; 2 - corrugated hose; 3 - temperature controller shutter handle; 4 - cold air intake; 5 - temperature controller; 6 - clamping bolt; 7 - cleaner cover nut; 8 - air cleaner cover; 9 - cleaner cover sealing strip; 10 - filtering element; 11 - cleaner cover attachment bracket; 12 - exhaust gas drawout manifold; 13 - air cleaner housing; 14 - spring clip; 15 - warm air intake from exhaust manifold zone

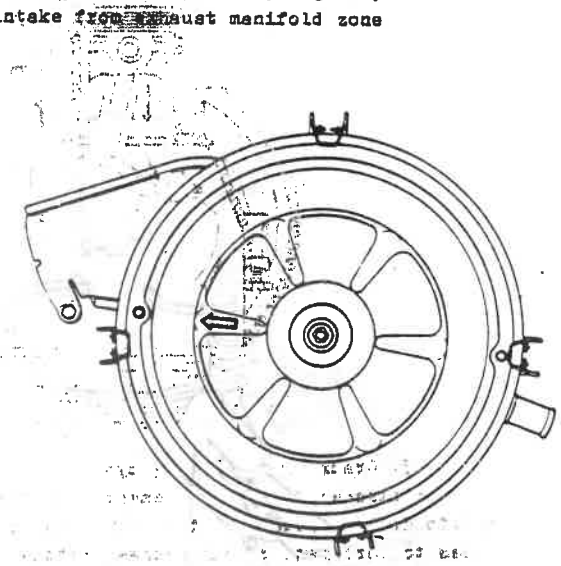

Fig.2-77. Mounting Air Cleaner Cover

Remove the rear seat, turn off the fastening screws of the R.H. and L.H. linings of the wheel arches and remove the linings.

Turn off the fastening screws and remove the cover of the fuel tank compartment.

Turn out the screws and remove the fuel tank compartment cover. Disconnect hoses 9 and the wires from fuel level transmitter 8 and hoses 2 fro gasoline fume separator 3.

Turn out the attachment bolts and remove the fuel tank.

To install the fuel tank reverse the removal operations.

Cleaning and Inspection. Remove the fuel level transmitter, wash the tank with gasoline to remove sediments. Then wash it with a stream of hot water and steam-treat it to remove remnants of gasoline.

Examine the fuel tank closely along the joint to make sure there are no leaks and, if necessary, soft-solder the leaky point.

Caution:

Soldering is permitted only on a thoroughly washed tank containing no gasoline fumes which may ignite during soldering.

Fuel Pump

The design of the fuel pump is shown in Fig.2-79.

Pump Checking. Insufficient supply of gasoline to the carburettor may be caused by a defect in the fuel pump, by choking or damage of the fuel lines.

To locate the cause of trouble disconnect the hose from delivery connection 1 and check fuel delivery by operating hand-priming lever 8. If no fuel is delivered, disconnect the hose from suction connection 4 and check for vacuum at the connection inlet. If there is vacuum, look for a trouble in the fuel lines, and if there is no vacuum, the fuel pump is at fault.

The fuel pump can be checked additionally on a stand. By rotating the drive shaft at a speed of 2000 ± 40 min^{-1} check the pump delivery (which should be not less than 54 l/h at 20 ± 5 °C) and the delivery pressure (which should be 2.2 - 3.0 mm of water column at no delivery). If there is some doubt in the condition of the pump, disassemble the pump and check its parts.

Disassembly, Cleaning and Checking Parts. To disassemble the pump turn out the bolts holding cover 5, remove the cover and filter 2. Turn out the screws holding the body to the lower cover and separate them, take out the diaphragm unit and the spring. Wash the parts in gasoline and blow them out with compressed air.

Check the pump springs for condition.

Check the pump valves for jamming. Check the state of the diaphragms. Cracks and age-hardening is not tolerable.

After checking, replace all worn out or defective parts with new ones. Replace the pump gaskets with new ones and before fitting them in place coat the gaskets with a thin layer of grease.

Installation of Pump on Engine. For correct installation of the fuel pump on the engine use two of the three gaskets indicated below: A - thickness 0.27 - 0.33 mm; B - thickness 0.70 - 0.80 mm and C - thickness 1.10 - 1.30 mm.

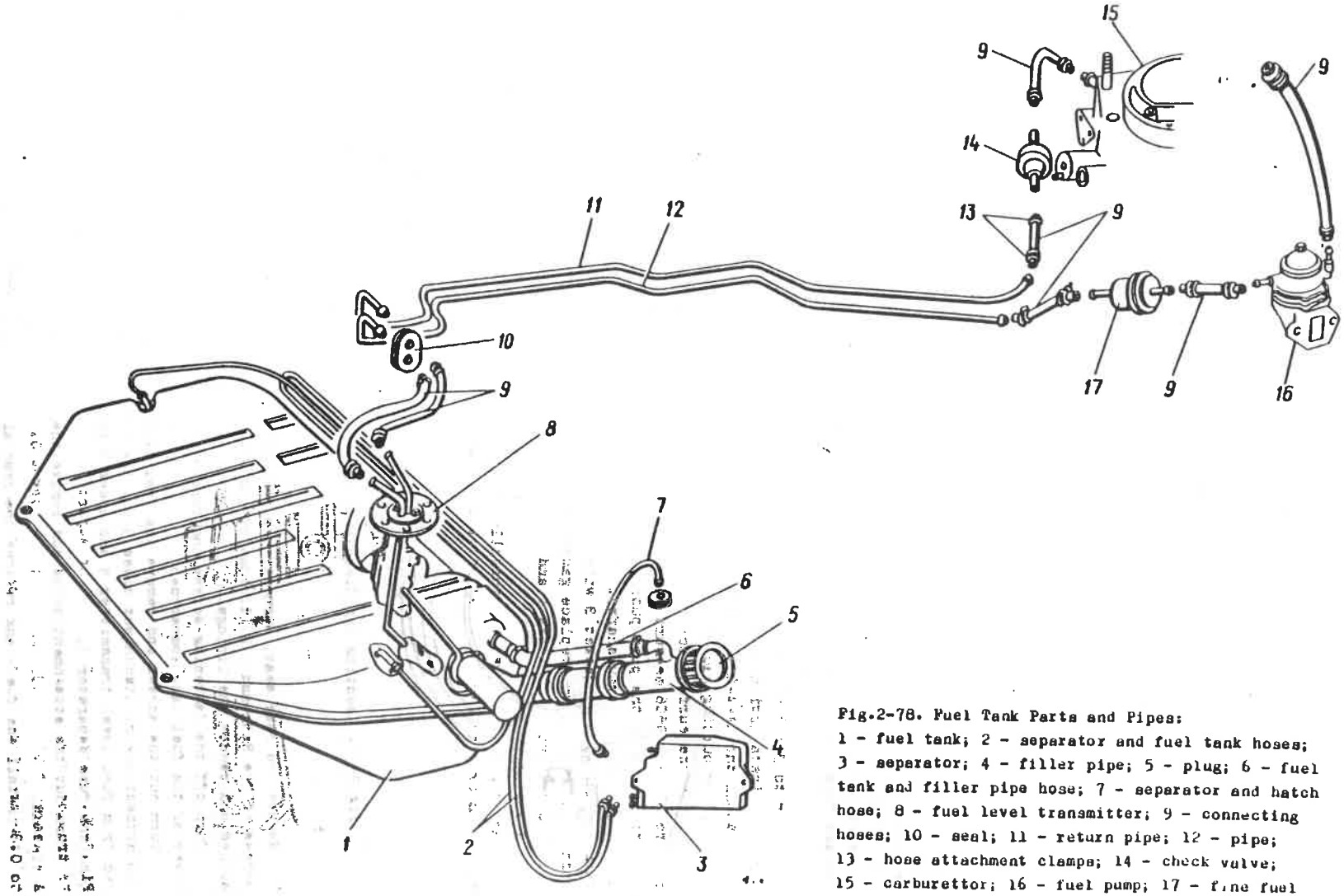

Fig.2-78. Fuel Tank Parts and Pipes:
1 - fuel tank; 2 - separator and fuel tank hoses; 3 - separator; 4 - filler pipe; 5 - plug; 6 - fuel tank and filler pipe hose; 7 - separator and hatch hose; 8 - fuel level transmitter; 9 - connecting hoses; 10 - seal; 11 - return pipe; 12 - pipe; 13 - hose attachment clamps; 14 - check valve; 15 - carburettor; 16 - fuel pump; 17 - fine fuel filter

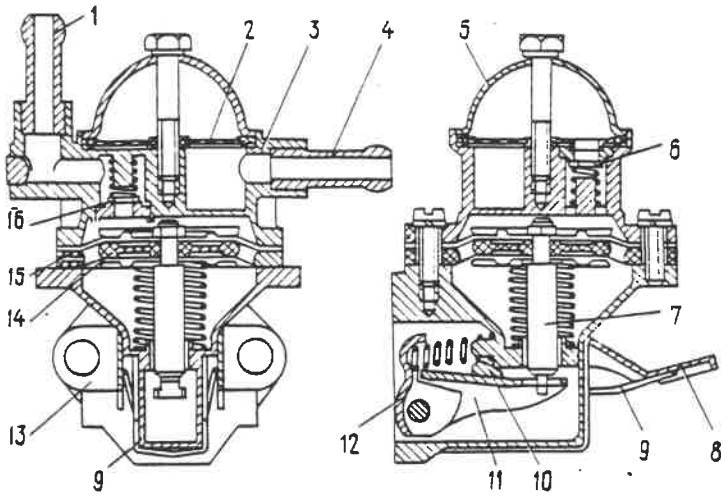

Fig.2-79. Fuel Pump:
1 - delivery connection; 2 - filter; 3 - body; 4 - suction connection; 5 - cover; 6 - suction valve; 7 - rod; 8 - hand-priming lever; 9 - spring; 10 - eccentric; 11 - rocker; 12 - operating lever; 13 - lower cover; 14 - inner spacer; 15 - outer spacer; 16 - discharge valve

Refer to Fig.2-80 showing how to install the pump. The installation procedure is as follows.

Install the heat-insulating spacer on the cylinder block putting gasket A in between and put gasket B on the surface contacting the pump. Using fixture 67.7834-9506 measure distance d (the minimum protrusion of the pump pushrod determined by slowly turning the crankshaft). If size d is less than 0.8 mm, replace gasket B with gasket A. If size d exceeds 1.3 mm, replace gasket B with gasket C. Once again check size d and secure the pump on the engine.

Gasket A should always be installed between the cylinder block and the heat insulating spacer.

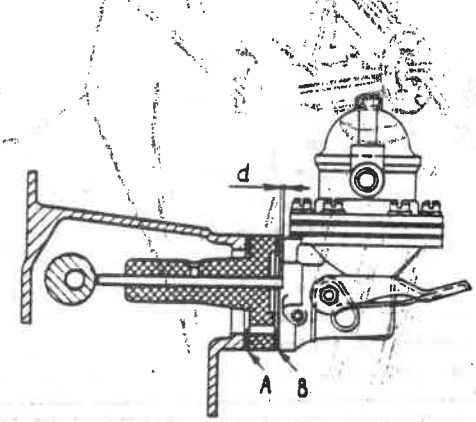

Fig.2-80. Diagram for Checking and Adjusting Protrusion of Pump Drive Pushrod:
A - gasket 0.27 to 0.33 mm thick; B - gasket 0.70 to 0.80 mm thick; d - pushrod protrusion

Carburettor

Design Peculiarities

The engine operates with carburettor 21073-1107010 (Fig.2-81) of emulsion double-barrel type with successive opening of the throttle valves. The carburettor has a balanced float chamber, a system to draw out crankcase gases and deliver them to behind-the-throttle space, heating system of the carburettor primary throttle valve zone and a secondary barrel interlock.

The carburettor employs two main metering systems of the primary and secondary barrels, primary barrel idling system with transfer system, secondary barrel transfer system, power duty economizer, econostat, diaphragm acceleration pump and a cold starting unit. At forced idling a limit speed economizer is cut in.

For calibration data of the carburettor refer to Table 2-3.

Main Metering System. Fuel through gauze filter 4 (Fig.2-82) and needle valve 6 is delivered into the float chamber wherefrom it gets through main fuel jets 9 into the emulsion wells and mixes with air coming out of the emulsion tube holes. The emulsion tubes are made integral with the main air jets. Through atomizers 2 the fuel-air emulsion gets into small and large venturies of the carburettor.

Throttle valves 8 and 10 are so connected that the secondary throttle starts opening when the primary one has opened through 2/3rd of its travel.

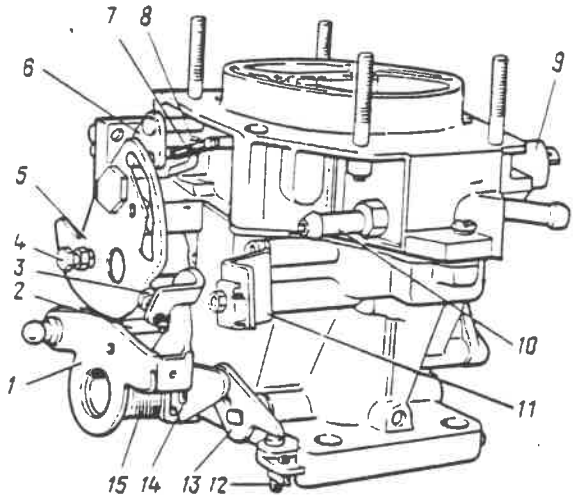

Fig.2-81. Carburettor 21073-1107010:
1 - throttle valve operating lever; 2 - secondary barrel interlock lever dowel; 3 - primary throttle valve cracking adjusting screw; 4 - choke valve cable attachment screw; 5 - choke valve control lever; 6 - choke valve lever; 7 - choke valve pull-back spring; 8 - cold starting unit diaphragm rod; 9 - electromagnetic shutoff valve; 10 - fuel feed connection; 11 - choke valve cable sheathing attachment bracket; 12 - secondary barrel adjusting screw; 13 - secondary throttle valve lever; 14 - secondary throttle valve operating lever; 15 - primary throttle valve return spring

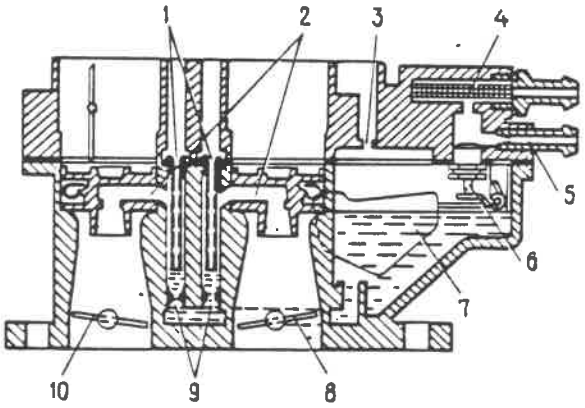

Fig.2-82. Diagram of Carburettor Main Metering Systems:
1 - main air jets with emulsion tubes; 2 - primary and secondary barrel venturies; 3 - balancing hole; 4 - fuel filter; 5 - connection with calibrated hole to return part of fuel into fuel tank; 6 - needle valve; 7 - float; 8 - secondary throttle valve; 9 - main fuel jets; 10 - primary throttle valve

Idling System takes fuel from the emulsion well after main fuel jet 7 (Fig.2-83). The fuel is fed to fuel jet 2 with electromagnetic shutoff valve 1 and at the jet outlet mixes with air getting from the through channel and from the widening part of the venturi (to provide normal operation of the carburettor at changing over to idle running). The emulsion comes out under the throttle valve through the hole adjusted by idle mixture (quality) screw 9.

Table 2-3

Calibration Data of Carburettor 21073-1107010

Parameters	Primary barrel	Secondary barrel
Barrel diameter, mm	32	32
Venturi diameter, mm	24	24
Main metering system:		
fuel jet marking*	107.5	117.5
air jet marking	150	135
Type of emulsion tube	2D	2C
Idling system and transfer system of primary barrel:		
fuel jet marking	39	–
air jet marking	140	–
Transfer system of secondary barrel:		
fuel jet marking	–	70
air jet marking	–	140
Economizer:		
fuel jet conventional flow rate**		70
Power duty economizer:		
fuel jet marking	40	–
spring compression force at length of 9.5 mm, N	1.5±10 %	
Acceleration pump:		
nozzle marking	45	–
fuel delivery per 10 cycles, cm^3	14	–
cam marking	4	–
Starting clearances and cam marking:		
cam marking	6	–
choke valve (clearance B), mm	3.0	–
throttle valve (clearance C), mm	1.1	–
Diameter of hole for vacuum spark timer, mm	1.2	
Diameter of needle valve hole, mm	1.5	
Diameter of hole to bypass fuel into tank, mm	0.70	
Diameter of engine crankcase breathing hole, mm	1.5	–

* Marking of the jets is determined by the flow rate measured with rotameters adjusted by reference jets.

** Conventional flow rate of the fuel jet is determined using a special method and a reference jet. This characteristic is not subject to checking in service.

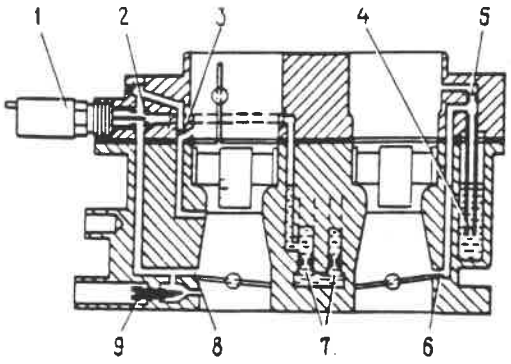

Fig.2-83. Carburettor Idling and Transfer Systems. Diagrammatic:
1 - electromagnetic shutoff valve; 2 - idle fuel jet; 3 - idle air jet; 4 - secondary barrel transfer system fuel jet with tube; 5 - secondary barrel transfer system air jet; 6 - secondary barrel transfer system outlet hole; 7 - main fuel jets; 8 - primary barrel transfer system slot; 9 - idle mixture (quality) adjusting screw

Transfer systems. With the throttle valves opened and main metering systems not yet cut in the fuel-air mixture passes:

into the primary barrel through idle jet 2 and into vertical slot 8 of the transfer system arranged at the closed throttle valve edge level;

into the secondary barrel through outlet hole 6 found slightly above the closed throttle valve edge level. The fuel passes from jet 4 through the tube, and mixes with air from jet 5 passing along the through channel.

Power duty economizer operates at a definite rarefaction behind throttle valve 5 (Fig.2-84). Fuel is taken from the float chamber through ball valve 8 which remains closed while the diaphragm is held in position by vacuum in the manifold. When the throttle valve opens through a considerable degree, vacuum drops somewhat and the spring of diaphragm 7 opens the valve. The fuel passing through economizer jet 9 is added to the fuel passing through main fuel jet 4, thus enriching the mixture.

Econostat operates at full load of the engine at speeds close to maximum values, with the throttle valves wide open. The fuel from the float chamber passes into the fuel pipe through jet 3 (Fig. 2-84) and gets sucked through spray tube 13 into the secondary barrel, thus enriching the fuel mixture.

Acceleration pump of diaphragm type, mechanically operated by cam 6 (Fig.2-85) on the shaft of the primary throttle valve. With the throttle valve closed the spring pulls diaphragm 3 backwards which results in filling the pump space with fuel through ball valve 8. With the throttle valve be-

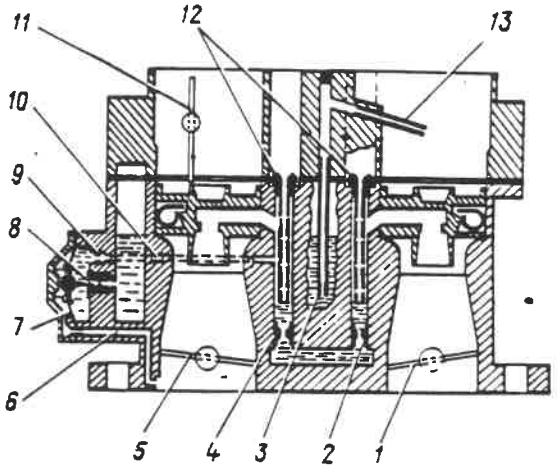

Fig.2-84. Power Duty Economizer and Econostat. Diagrammatic:
1 - secondary throttle valve; 2 - secondary barrel main fuel jet; 3 - econostat fuel jet with tube; 4 - primary barrel main fuel jet; 5 - primary throttle valve; 6 - vacuum feed channel; 7 - economizer diaphragm; 8 - ball valve; 9 - economizer fuel jet; 10 - fuel channel; 11 - choke valve; 12 - main air jets; 13 - econostat spray tube

ing opened, the cam acts on lever 5, and diaphragm 3 delivers the fuel through ball valve 2 and nozzle 1 into the carburettor barrel, thus enriching the mixture.

Pump capacity is not subject to adjustment, it depends only on the shape of the cam.

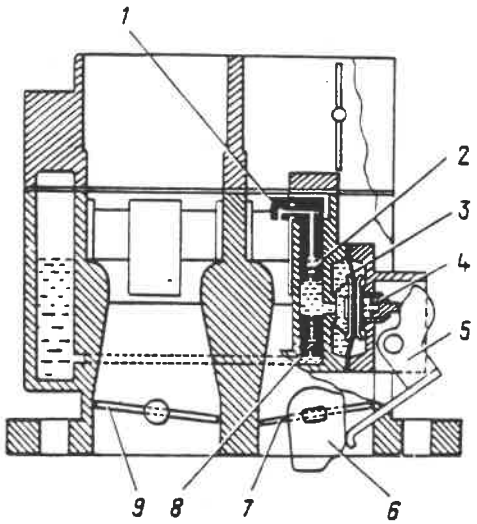

Fig.2-85. Acceleration Pump Diagram:
1 - nozzle; 2 - fuel feed ball valve; 3 - pump diaphragm; 4 - pusher; 5 - operating lever; 6 - pump operating cam; 7 - primary throttle valve; 8 - check ball valve; 9 - secondary throttle valve

Cold-starting unit. Lever 4 (Fig.2-86) of the choke valve has three different profiles. Its outer edge 4.3 acts on throttle valve control lever 11 through adjusting screw 10, thus providing starting of a cold engine and required crankshaft speed rise. Inner profiles 4.1 and 4.2 act onto choke valve lever 6 to provide its opening through a definite value at intermediate positions of lever 4. With choke valve control lever 4 turned counter-clockwise the widening slot releases the dowel of choke valve lever 6, and pull-back spring 7 will hold the valve completely closed. Simultaneously lever 4 cracks the primary throttle valve by its edge 4.3.

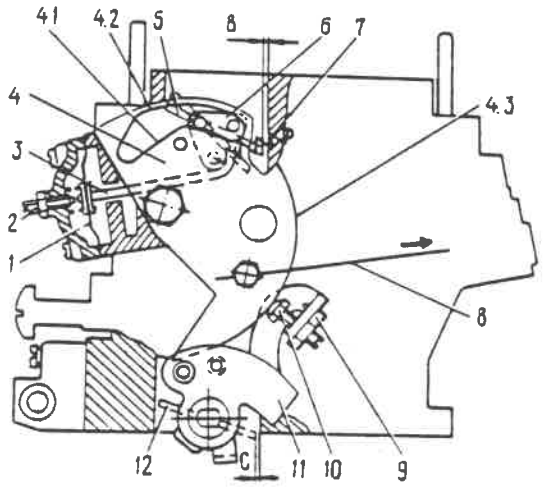

Fig.2-86. Carburettor Cold Starting Unit:
1 - diaphragm; 2 - adjusting screw; 3 - diaphragm rod; 4 - choke valve control lever:
4.1 - lower profile of slot in lever 4 to limit maximum opening of choke valve; 4.2 - upper profile of slot providing mechanical opening of choke valve; 4.3 - edge of lever 4 to provide starting clearance of primary throttle valve; 5 - choke valve; 6 - choke valve lever; 7 - choke valve pull-back spring; 8 - choke valve control cable; 9 - adjusting screw stop; 10 - primary throttle valve cracking adjusting screw; 11 - throttle valve operating lever; 12 - primary throttle valve;
B - starting clearance at choke valve;
C - starting clearance at throttle valve

The shaft of choke valve 5 is displaced, thanks to it the choke valve can be cracked by the air stream after starting the engine, expanding spring 7, and thus leaning the mixture.

Vacuum from the behind-the-throttle space acts on diaphragm 1 and rod 3 cracks the choke valve. Adjusting screw 2 permits adjusting of choke valve opening.

Maximum opening of the choke valve at starting and warming up of the engine depends on the intermediate positions of choke valve control lever 4 or the width of the lever slot.

Limit-speed economizer cuts off the idling system at forced idling (at engine braking, moving down the slope, gearshifting) thus preventing discharge of carbon oxide into the atmosphere.

At forced idling at a crankshaft speed exceeding 2100 min^{-1} and with carburettor limit switch 7 (Fig.7-40) connected to the ground (pedal released), electromagnetic shutoff valve 6 gets de-energized and cuts off fuel supply.

When the crankshaft speed at forced idling drops to 1900 min^{-1}, the control unit cuts in the shutoff valve (although the limit switch remains connected to the ground) and fuel starts flowing through the idle jet and the engine gradually acquires idling speed.

Interlocking of secondary barrel. The secondary barrel throttle valve can open only when the choke valve is opened by the secondary barrel interlock lever installed on lever 1 (Fig.2-81). With the throttle valves being opened the interlock lever acts through operating lever 14 of the secondary throttle valve onto secondary throttle valve lever 13.

With the choke valve being closed, lever 5 with its outer edge acts onto interlock lever dowel 2 and disengages it from lever 14. In this position the secondary throttle valve is interlocked and cannot be opened.

Removal and Installation of Carburettor

Removal and installation of the carburettor should be carried out only on a cold engine. The procedure is as follows. Remove the air cleaner. Disconnect rod 15 (Fig.2-87) from throttle valve operating lever 1 (Fig.2-81) and disconnect cable 3 and the choke valve control cable sheathing from the carburettor. Turn out the attachment screw and remove the carburettor heating unit.

Disconnect from the carburettor the electric wires of the electromagnetic shutoff valve and the limit-speed economizer limit switch.

Turn off the carburettor attachment nuts, remove the carburettor and stop by a plug the intake manifold inlet hole.

To install the carburettor reverse the removal operations. Prior to installing the carburettor check condition of the carburettor spacer and planes of connection of the intake manifold and the carburettor. Nut tightening torque is indicated in Appendix 1.

DO NOT tighten the attachment nuts when the carburettor is warm.

Having installed the carburettor adjust the control linkage and engine idle speed.

The carburettor control linkage should not bind.

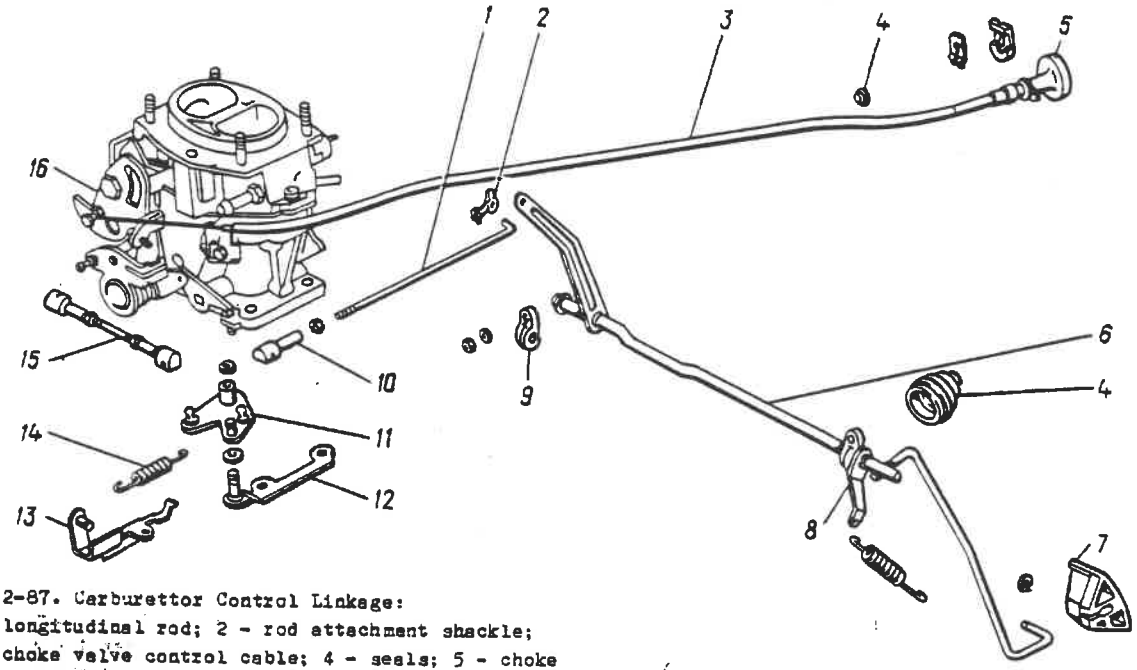

Fig.2-87. Carburettor Control Linkage:
1 - longitudinal rod; 2 - rod attachment shackle; 3 - choke valve control cable; 4 - seals; 5 - choke valve control knob; 6 - shaft; 7 - accelerator pedal; 8 - return spring lever; 9 - shaft attachment bracket; 10 - longitudinal rod endpiece; 11 - intermediate lever; 12 - intermediate lever bracket; 13 - return spring bracket; 14 - return spring; 15 - cross rod; 16 - carburettor

Disassembly of Carburettor

Turn out the upper body attachment screws and remove the upper body taking care not to damage the gasket, float, tubes of the economizer and secondary barrel transfer system.

Disassemble the carburettor upper body.

Using a driver carefully push out shaft 1 (Fig.2-88) of floats 3 from the supports taking care not to damage float tongues, and remove the floats.

Remove gasket 4 of the upper body, turn out the seat of needle valve 2, turn out fuel feed connection 15 and take out fuel filter 13.

Turn out the body of the idle fuel jet with electromagnetic shutoff valve 10 and take out jet 9.

Turn out shaft 19, take out ball 17 with the spring, remove choke valve control lever 18, and disconnect the spring of the choke valve control lever. If necessary, turn out the screws holding the choke valve and take out valve 14 and shaft 16.

Disassemble the diaphragm cold starting unit having removed cover 8 complete with adjusting screw 7. Take out spring 6 and diaphragm 5 with the rod.

Disassemble the carburettor body (Fig.2-89) proceeding as follows:

Remove acceleration pump cover 3 with lever 2 and diaphragm 1.

Take out acceleration pump nozzle 10 and venturies 11 of the primary and secondary barrels. When removing nozzle 10 hold it only by its body.

Turn off the nut of the primary throttle valve shaft and remove operating cam 4 of the acceleration pump and the washer.

Turn out the attachment screw, remove electric wire 30 from idle speed (quantity) adjusting screw 29 and turn out screw 29.

Using a corkscrew turn out plastic plug 25 and turn out idle mixture (quality) adjusting screw 27.

Remove cover 5 of the power duty economizer, diaphragm 6 and the spring.

Turn out fuel jet 7 of the power duty economizer.

Turn out main air jets 12 with the emulsion tubes and main fuel jets 13 of the main metering systems.

Cleaning and Checking Condition of Carburettor Parts

Fuel filter. Wash the filter in gasoline and flow it through with compressed air. Check condition of the filter. If the filter or the fuel feed connection are damaged, replace them with new ones.

Float mechanism. Wash the parts in gasoline and check their condition. The floats should be intact. On the sealing surface of the needle valve and its seat there should be no defects affecting the tightness of the valve. The valve should be free to move in its seat and the ball should not stick. The weight of the floats should not exceed 6.23 g. Replace all defective parts.

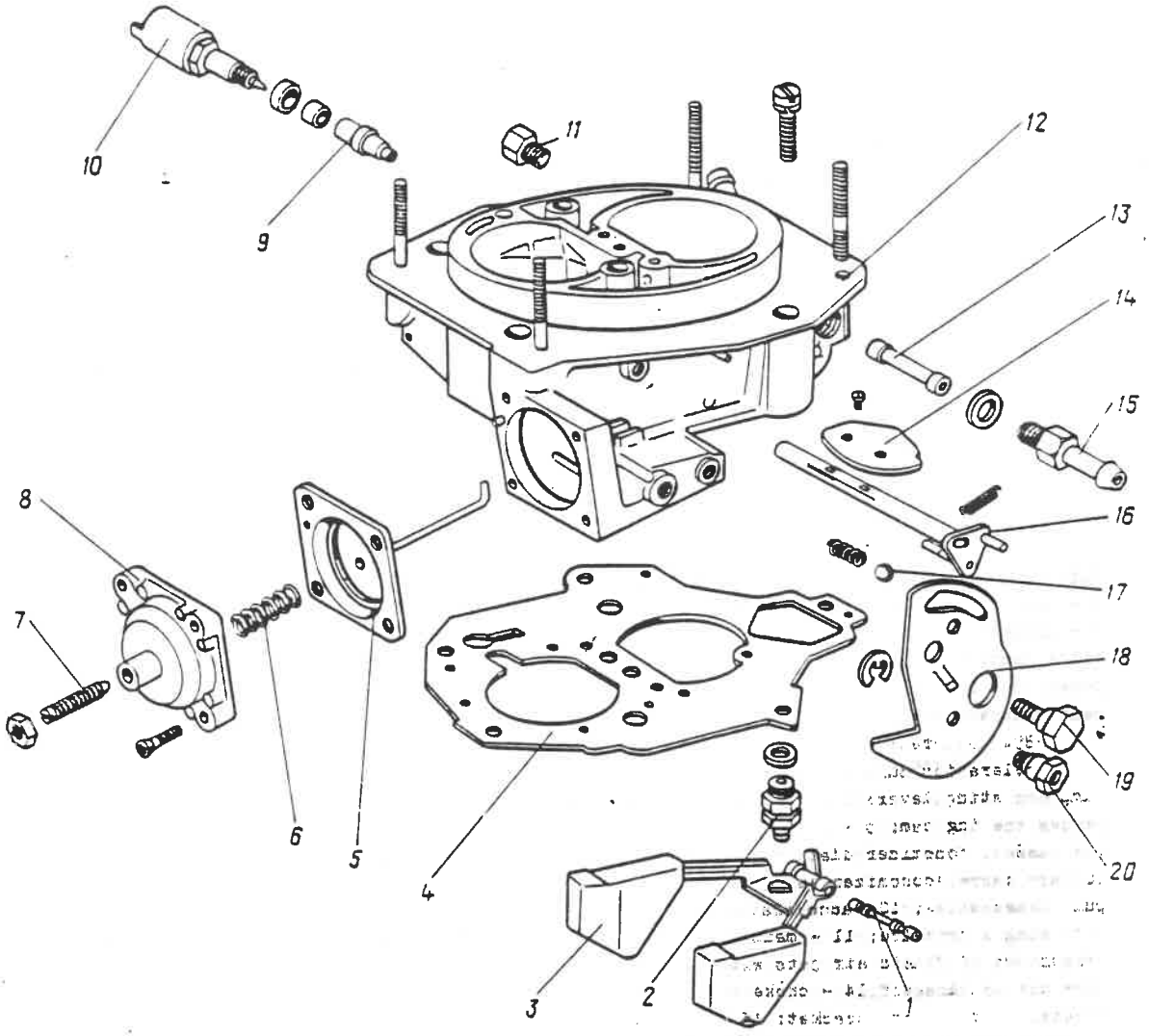

Fig.2-38. Carburettor Upper Body Parts:
1 - float shaft; 2 - needle valve; 3 - float; 4 - gasket; 5 - cold starting unit diaphragm with rod; 6 - spring; 7 - adjusting screw; 8 - cold starting unit cover; 9 - idle fuel jet; 10 - electromagnetic shutoff valve; 11 - plug; 12 - carburettor upper body; 13 - fuel filter; 14 - choke valve; 15- fuel feed connection; 16 - choke valve shaft with lever; 17 - choke valve control lever detent ball; 18 - choke valve control lever; 19 - lever shaft; 20 - choke valve control cable attachment bushing

Carburettor upper body. Clean from dirt and oil the carburettor upper body and all holes and passages. Wash the upper body in acetone or gasoline and blow it through with compressed air. Inspect the sealing surfaces of the upper body. Replace the upper body with a new one, if damaged.

Cold-starting unit. Clean all parts of the cold-starting unit, wash them in gasoline and blow through with compressed air. Inspect the parts and replace damaged ones, if any.

Jets and emulsion tubes. Clean the jets and emulsion tubes from dirt and gummy deposits, wash them in acetone or gasoline and blow through with compressed air.

Do not clean the jets with a metal tool or a piece of wire, nor wipe the jets and other parts of the carburettor with cotton wool, cloth or rags as lints might clog the fuel-emulsion passage. Badly contaminated jets may be cleaned with a soft wood needle wetted with acetone.

Carburettor body. Clean the body from dirt and oil. Wash all passages with acetone or gasoline and blow them through with compressed air. If necessary, clean the passages and emulsion tubes with special reamers. Inspect the sealing surfaces of the body. If the surfaces are damaged or out-of-shape, replace the body with a new one.

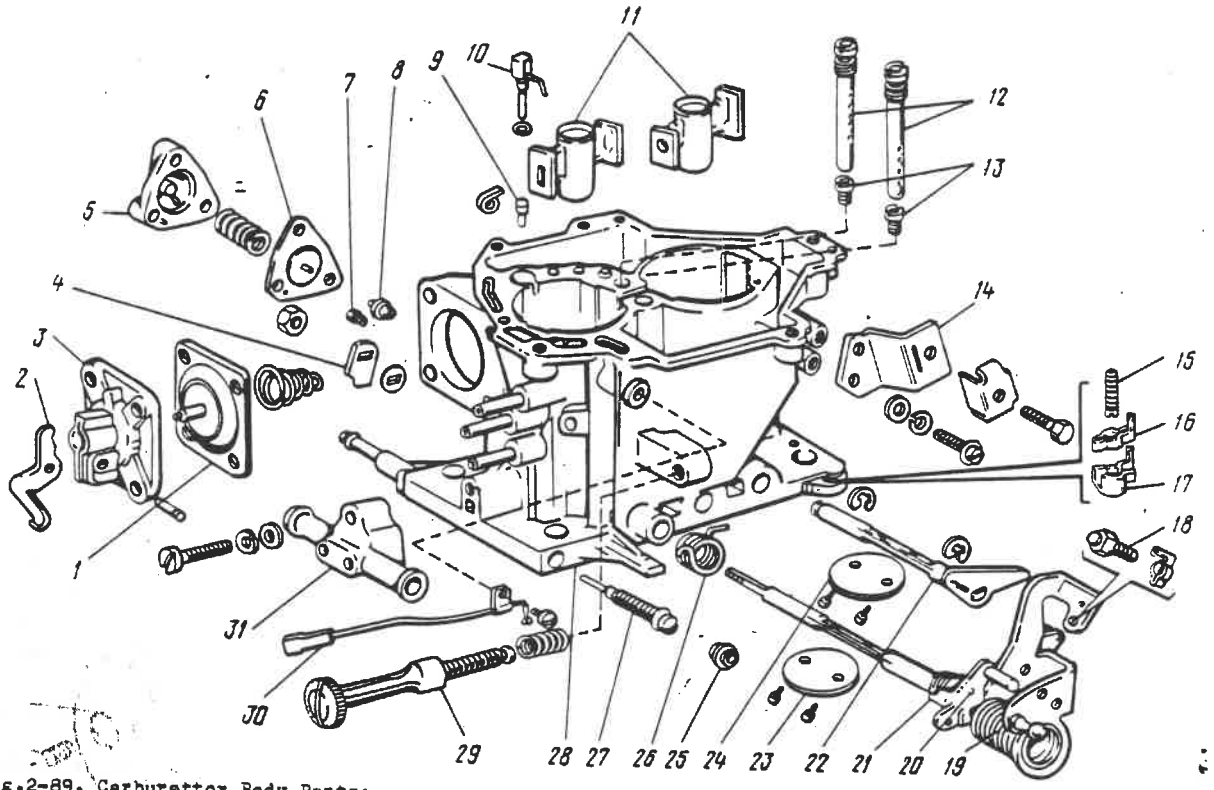

Fig.2-89. Carburettor Body Parts:
1 - acceleration pump diaphragm; 2 - acceleration pump operating lever; 3 - cover; 4 - acceleration pump operating cam; 5 - power duty economizer cover; 6 - economizer diaphragm; 7 - economizer fuel jet; 8 - economizer valve; 9 - acceleration pump check valve; 10 - acceleration pump nozzle with fuel feed valve; 11 - main metering system venturies; 12 - main air jets with emulsion tubes; 13 - main fuel jets; 14 - choke valve control cable sheathing attachment bracket; 15 - secondary barrel adjusting screw; 16 - adjusting screw stop; 17 - stop cap; 18 - primary throttle valve cracking adjusting screw; 19 - primary throttle valve shaft with operating levers; 20 - secondary barrel interlock lever; 21 - interlock lever spring; 22 - secondary throttle valve shaft with lever; 23 - primary throttle valve; 24 - secondary throttle valve; 25 - idle mixture (quality) adjusting screw plug; 26 - secondary throttle valve operating lever return spring; 27 - idle mixture (quality) adjusting screw; 28 - carburettor body; 29 - idle speed (quantity) adjusting screw; 30 - limit speed economizer limit switch electric wire; 31 - carburettor heating unit

Acceleration pump. Clean the parts of the pump, wash them in gasoline and blow through with compressed air. Check the ball in the nozzle for easy travel and check movement of the pump movable members (lever, diaphragm parts). Binding is not tolerable. The diaphragm should be intact. Check condition of the sealing surfaces and gaskets. Replace defective parts with new ones.

Power duty economizer. The diaphragm should be intact. If the length of the diaphragm pushrod, including the head, is less than 6.0 mm, replace the diaphragm in assembly with the pushrod.

Assembly of Carburettor

Assemble the carburettor in the sequence reverse to its disassembly. Pay attention to the following.

The float should turn freely on its shaft, without brushing the walls of the float chamber.

The needle valve should slide freely in its seat without cocking and jamming. The tightening torque of the needle valve seat should be 14.7 N.m (1.5 kgf.m).

The tightening torque of the electromagnetic shutoff valve should be 3.68 N.m (0.4 kgf.m).

Pay attention to the jet marking and refer to Table 2-2 not to confuse the jets during their installation.

Prior to fitting shaft 19 (Fig.2-88) coat the end of the shaft and the extreme 1 - 1.5 threads with sealant УТ-9.

When assembling the acceleration pump turn in the cover attachment screws but do not tighten them, press the operating lever to stop, then tighten up the screws and release the lever.

Adjustment and Checking of Carburettor

Adjusting fuel level in float chamber. Fuel level required for reliable operation of the carburettor is provided by correct setting of the shutoff elements which should be in good repair.

Check position of float 1 (Fig.2-90) with gauge 4 to be placed square to upper body 2 which should be held horizontally with the floats facing up. A clearance not greater than 1 mm should be left between the contour of the gauge and the floats.

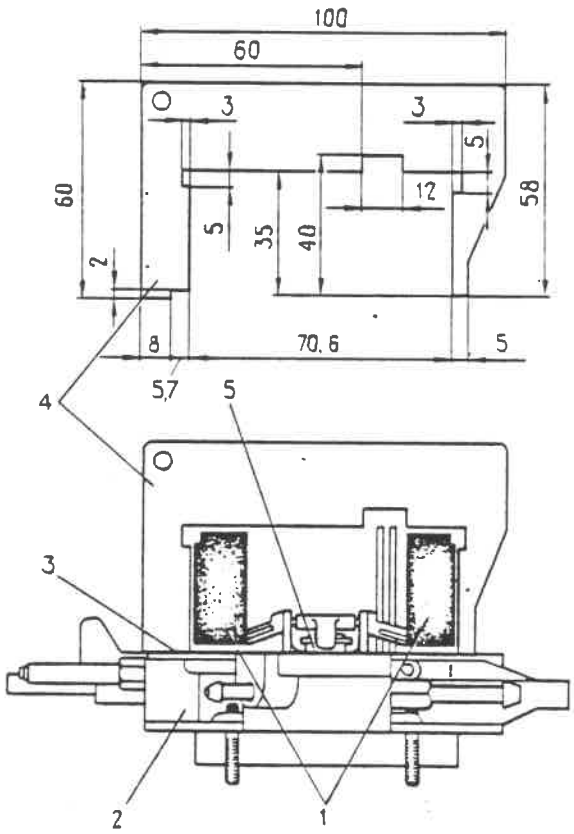

Fig.2-90. Adjustment of Fuel Level in Carburettor Float Chamber:
1 - float; 2 - carburettor upper body; 3 - sealing gasket; 4 - float position check gauge; 5 - needle valve

If necessary, adjust by bending the tongue and levers of the float. The bearing surface of the tongue should be square to the axis of needle valve 5 and should be free from dents and nicks.

Adjusting cold-starting unit. With control lever 4 (Fig.2-86) of choke valve 5 turned counter-clockwise to stop the choke valve should be completely closed under the action of spring 7. If the choke valve is not closed, eliminate the cause of trouble.

With the choke valve completely closed press rod 3 of the cold starting unit to stop. Choke valve 5 should open by 3.0 mm (starting clearance B). Adjust, if necessary by screw 2.

With the choke valve completely closed, primary throttle valve 12 should be opened by 1.1 mm (starting clearance D). If necessary, adjust the clearance by screw 10.

Adjusting carburettor control linkage. With accelerator pedal 7(Fig.2-87) pressed to stop, the primary throttle valve should be wide open and rod 15 should have no additional travel. With pedal 7 released the throttle valve should be completely closed. If no, adjust the position of the pedal and the throttle valve by endpiece 10 on the front end of longitudinal rod 1.

Secure the end of cable 3 in the choke valve linkage so that with choke valve knob 5 pulled out the choke valve should be completely closed and with the knob pushed all way in, completely open.

Idle speed adjustment. Idle speed adjustment is provided by idle mixture (quality) adjusting screw 2 (Fig.2-91) and idle speed (quantity) adjusting screw 1. Adjusting screw 2 is closed by plug 4. To get access to the screw take out the plug with a corkscrew.

Idle speed adjustment should be carried out on a warmed up engine (coolant temperature of 90 - 95 °C) with correct valve clearances, ignition timing and wide open choke valve.

Set the crankshaft speed by idle speed screw 1 within 750 and 800 min^{-1} as read from the stand tachometer.

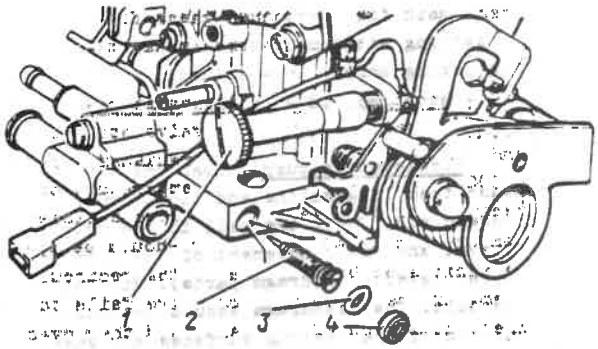

Fig.2-91. Idle System Adjusting Screws:
1 - idle speed (quantity) adjusting screw;
2 - idle mixture (quality) adjusting screw;
3 - sealing ring; 4 - adjusting screw plug

By manipulating with idle mixture screw 2 set CO content in the exhaust gases not exceeding 3 % for this position of screw 1 (CO content should be corrected to 20 °C and 101.3 kPa (760 mm Hg)).

Restore by screw 1 the crankshaft speed to 750 - 800 min^{-1}.

If necessary, correct CO content to 3 % by adjusting screw 2.

The adjustment done, sharply press the accelerator pedal and release it: the engine should rev up without misses and should not stall when the pedal is released. If the engine stalls, increase the crankshaft speed to 750 - 800 min^{-1} by screw 1.

Install new plastic plug 4 into the hole for idle mixture adjusting screw 2.

Checking operation of secondary barrel interlock mechanism. Turn the choke valve control lever counter-clockwise to close the valve completely. Then turn throttle valve control shaft lever 19 (Fig.2-89) to widely open primary throttle valve 23; secondary throttle valve 24 should remain closed.

Turn the choke valve control lever clockwise to stop and the throttle valve control lever to widely open the throttle valves. If the throttle valve of the secondary barrel fails to open, eliminate the trouble. A cause of the trouble may be jamming of secondary barrel interlock lever 20 or disconnection of interlock lever spring 21.

Exhaust Gas Recirculation System

The car is furnished with an exhaust gas recirculation system comprising thermovacuum switch 12 (Fig.2-92) and recirculation valve 9 with channel and recirculation tube 8 placed in intake manifold 11.

At an engine coolant temperature exceeding 40-48 °C, thermovacuum switch 12 operates and vacuum is supplied to recirculation valve 9; the valve opens and part of exhaust gases from exhaust manifold 10 is sucked into the intake manifold and the engine.

Checking operation of exhaust gas recirculation system. Press the throttle valve operating lever and gradually increase the crankshaft speed to 2500 - 3000 min^{-1}. At a coolant temperature of 30 - 38 °C, recirculation valve 9 should remain closed and at a temperature of 40 - 48 °C it should be open which is manifested by the rise of the recirculation valve stem. If the recirculation valve fails to open, check condition of the valve and thermovacuum switch 12.

To check recirculation valve 9 disconnect it from thermovacuum switch 12 and deliver vacuum into the valve diaphragm space by a hand vacuum pump. At a vacuum of 9.3 kPa (70^{+5} mm Hg) the valve should be closed.

At a vacuum exceeding 59.9 kPa (450^{+5} mm Hg) the valve should be wide open which is checked by sharply removing the vacuum: the valve should close with a specific click. Air leakage at both duties is not tolerable during 5 s.

When checking thermovacuum switch 12 disconnect the hose from the switch and from recirculation valve 9. Deliver vacuum of 13.3 kPa (100±5 mm Hg) to the thermovacuum switch by a hand vacuum pump. At a coolant temperature not exceeding

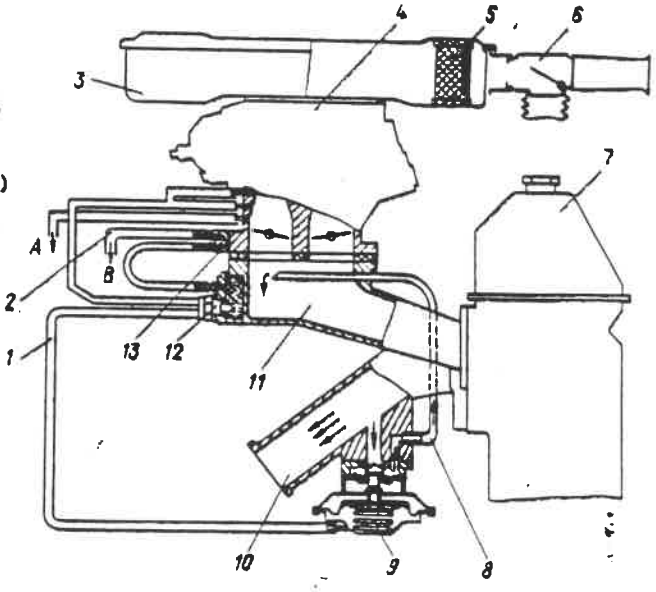

Fig.2-92. Connection Diagram of Carburettor Hoses and Pipes:
1 - hose to feed vacuum to recirculation valve;
2 - hose to let out liquid from carburettor heating unit; 3 - air cleaner; 4 - carburettor;
5 - air cleaner filtering element; 6 - temperature controller; 7 - engine; 8 - recirculation pipe;
9 - recirculation valve; 10 - exhaust manifold;
11 - intake manifold; 12 - rectirculation valve thermovacuum switch; 13 - carburettor heating unit;
A - to vacuum spark timer;
B - to coolant pump

30 - 38 °C, vacuum leakage is not tolerable (the thermovacuum switch is closed). At a coolant temperature less than 40 - 48 °C no vacuum should be built (the thermovacuum switch is open).

Exhaust Gas Discharge System

Exhaust gases are discharged from the engine through the exhaust manifold, muffler inlet pipe 2 (Fig.2-93), auxiliary miffler 7 and main muffler 6.

Sealing gasket 1 is placed between the flanges of the exhaust manifold and the inlet pipe. The pipes of the muffler are interconnected by flared ends with the help of clamps 4 with taper rings.

Inlet pipe 2 is secured by nuts on the studs of the exhaust manifold and on bracket 3 installed on the gearbox cover. Locking plates are fitted under the nuts holding the pipe to the manifold. The nuts and sealing gasket 1 are not intended for reuse. Main muffler 6 is suspended to the body floor on two pads 5.

The mufflers together with the pipes form non-detachable units and in case of failure, they should be replaced by new ones.

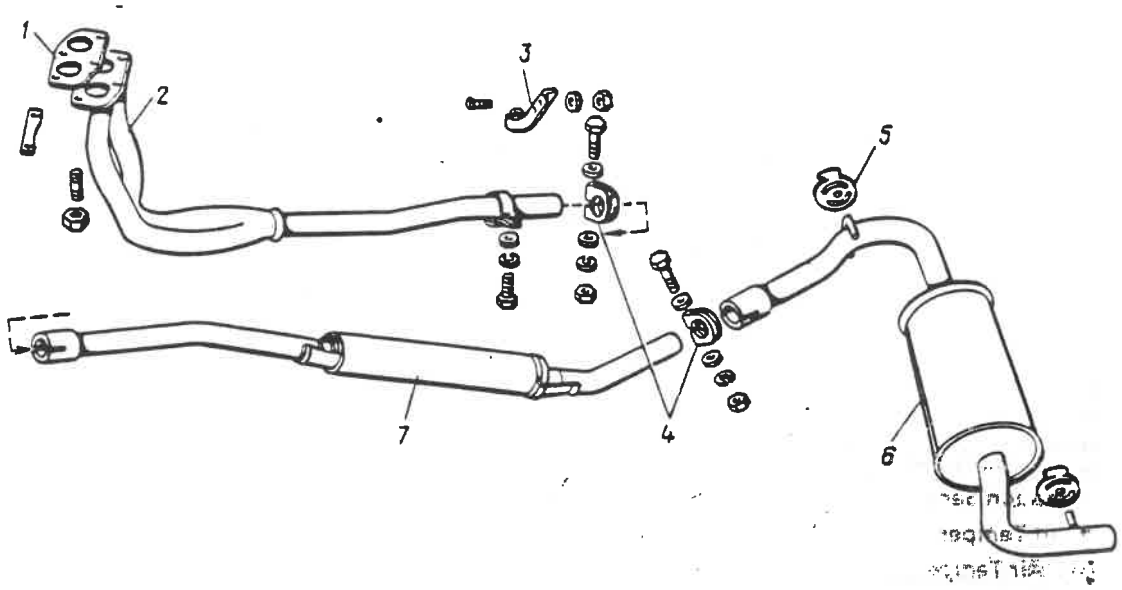

Fig.2-93. Exhaust System:
1 - sealing gasket; 2 - muffler inlet pipe; 3 - inlet pipe-to-gearbox attachment bracket; 4 - pipe attachment clamps; 5 - main muffler attachment pad; 6 - main muffler; 7 - auxiliary muffler

ENGINE MANAGEMENT SYSTEMS

1.7L THROTTLE BODY INJECTION

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1. GENERAL DESCRIPTION AND SYSTEM OPERATION

The engine used in this vehicle is equipped with electronic fuel injection and uses an electronic control module to control exhaust emissions while maintaining excellent driveability and fuel economy. The electronic control module maintains a desired air/fuel ratio of 14.7 to 1.

In addition to fuel control, the electronic control module also controls ignition dwell and timing, idle speed, electric fuel pump, an instrument panel "Check Engine" light, and the air conditioning compressor clutch. Figure 1-1 contains a list of the various operating conditions sensed by the electronic control module on the left, and the various systems controlled on the right.

The electronic control module has a built-in diagnostic system that recognizes and identifies possible operational problems and alerts the driver by lighting the "Check Engine" light in the instrument panel. If the light comes "ON" while driving, it does not mean that the engine should be stopped immediately, but the cause of the light coming "ON" should be checked as soon as is reasonably possible. The electronic control module has built-in backup systems that in all but the most severe failures will allow the vehicle to operate in a near normal manner until repairs can be made.

The assembly line data link connector is used by the assembly plant for a computer check-out of the engine management system. The assembly line data link is located in the passenger compartment. This connector is used during servicing to help diagnose the engine management system. Refer to "Diagnosis," in Section "2" for further details.

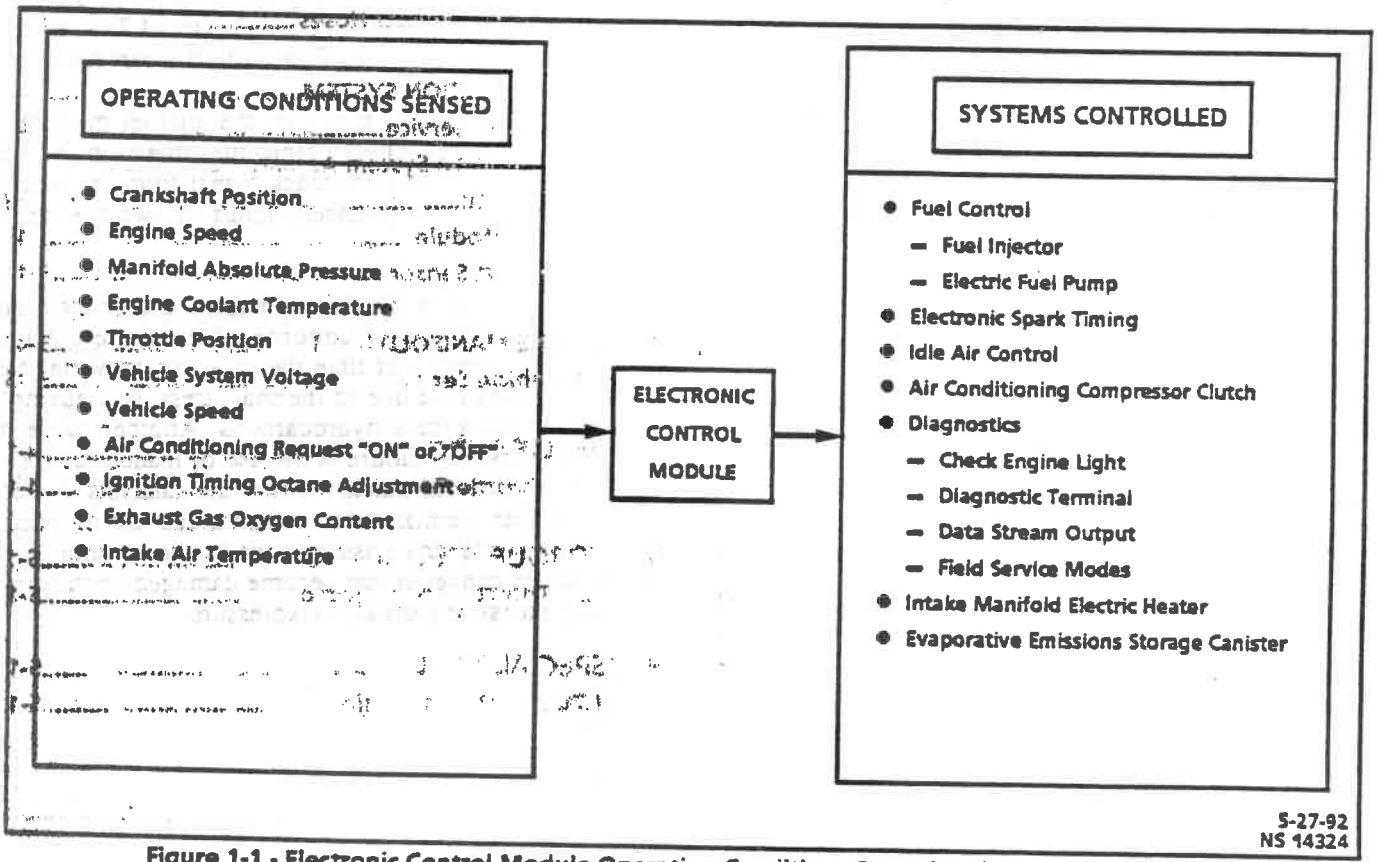


Figure 1-1 - Electronic Control Module Operating Conditions Sensed and Systems Controlled

Air pollution, and harmful exhaust emissions

In the past, automobile manufacturers have used many methods to meet increasingly stringent air pollution standards. These methods have included crankcase ventilation systems, adjustments of engine compression, camshaft profile, ignition spark timing, and modifications to carburetion. While carburetors can be modified and adjusted to provide reasonable accuracy of the air/fuel mixture at some operating conditions, it is difficult for a carburetor to precisely control the mixture at all possible operating conditions of an engine. And over time, a carburetor may require maintenance, including careful, and precise adjustments.

While the methods listed above have been somewhat effective, there is a more effective method of reducing harmful exhaust emissions, while at the same time improving the overall operation of the engine. This method is to use a catalytic converter in the exhaust system, and equip the engine with an electronic fuel injection system.

An electronic fuel injection system is the best method of maintaining total control of the air/fuel mixture over all operating conditions. It requires no adjustments, and will maintain optimum catalytic converter efficiency over very long periods of time. As an added benefit, the electronic fuel injection system has no adverse effects on fuel economy, and actually improves engine responsiveness and overall vehicle driveability.

Catalytic Converters

A catalytic converter has the ability to significantly reduce harmful exhaust emissions, if the engine combustion process is carefully controlled. This means that the air/fuel mixture being drawn into the engine must be very carefully and accurately metered, in order for the catalytic converter to reduce harmful exhaust emissions efficiently. These harmful exhaust emissions are hydrocarbons, carbon monoxide, and oxides of nitrogen.

A catalyst accelerates a chemical reaction without changing its own properties. The catalytic converter used in the throttle body fuel injection system is a "three-way" converter. It contains two oxidizing catalysts and a reducing catalyst, to accelerate a conversion process of hydrocarbons, carbon monoxide, and oxides of nitrogen into something less harmful.

The oxidizing catalysts are platinum and palladium. They add oxygen to the hydrocarbons and carbon monoxide in the exhaust, to convert hydrocarbons to water vapor and carbon monoxide to carbon dioxide.

The reducing catalyst is rhodium. It speeds up a chemical reaction by removing oxygen from the oxides of nitrogen, to convert oxides of nitrogen to harmless nitrogen, which makes up the major portion of the air we breathe.

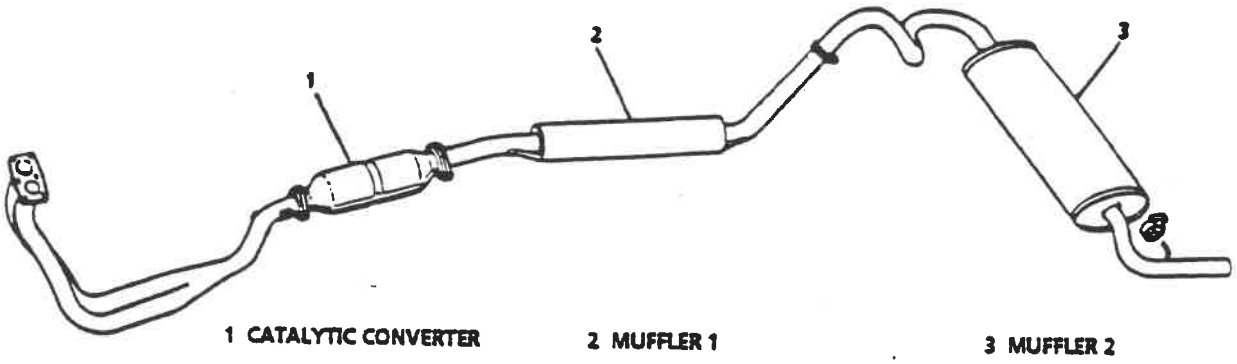
Because the catalytic converter needs oxygen to convert hydrocarbons and carbon monoxide, and yet must remove the oxygen to convert oxides of nitrogen, a very careful balance of the air/fuel mixture going into the engine must be maintained.

Too much remaining oxygen in the exhaust after combustion (lean exhaust) makes it difficult for the catalytic converter to remove oxygen from the oxides of nitrogen. Too little remaining oxygen in the exhaust after combustion (rich exhaust) makes it difficult for the catalytic converter to add oxygen to the carbon monoxide and hydrocarbons. Only a careful balance of the air/fuel mixture will allow the catalytic converter to effectively convert all three pollutants.

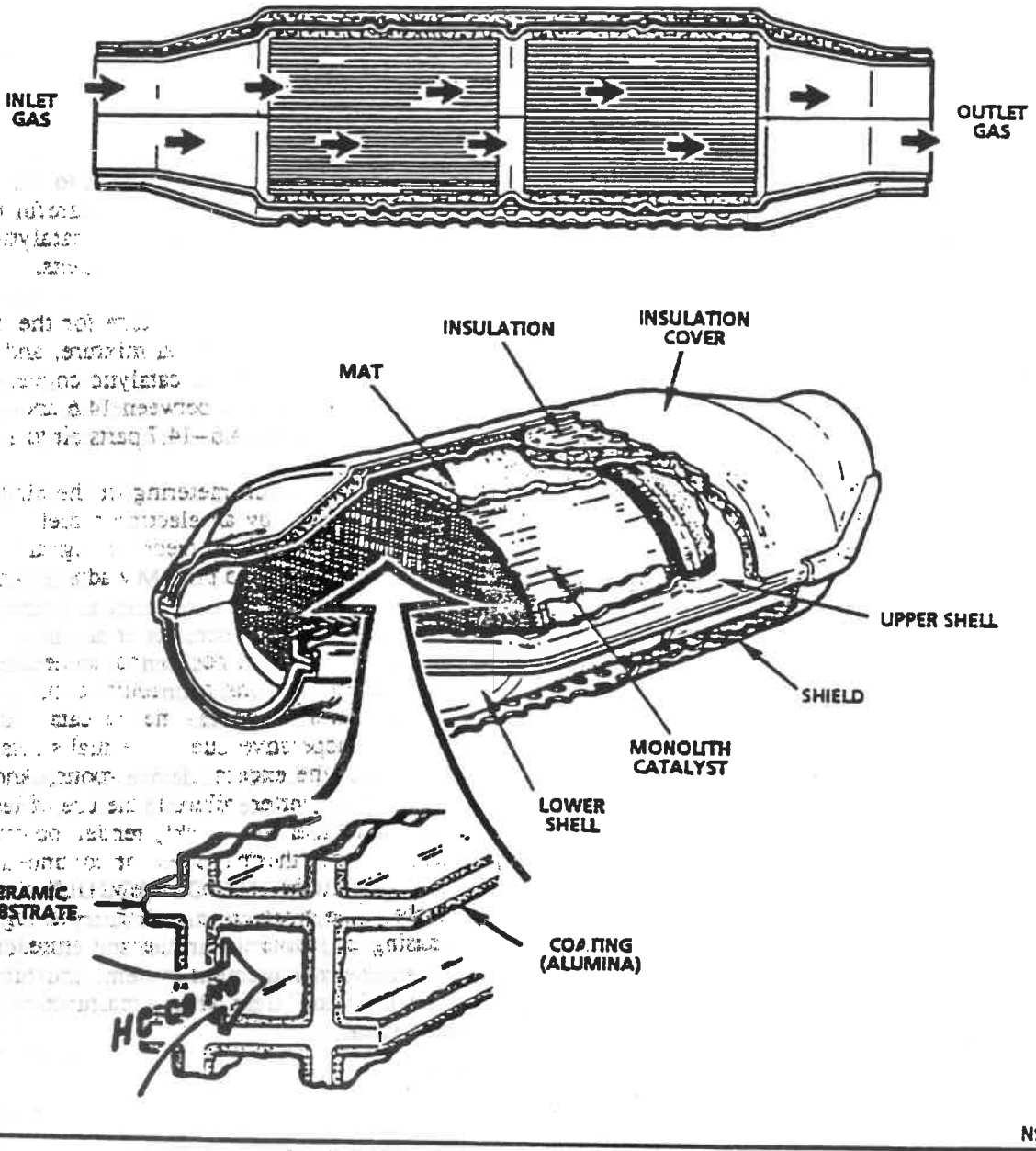
The ideal air/fuel mixture for the most complete combustion of the air/fuel mixture, and the most efficient conversion by the catalytic converter of the three exhaust pollutants, is between 14.6 and 14.7 : 1 air/fuel ratio. This means 14.6–14.7 parts air to 1 part fuel.

Such precision metering of the air/fuel mixture is best performed by an electronic fuel injection system, utilizing a closed-loop feedback signal from an exhaust gas oxygen sensor to precisely adjust its own fuel delivery calculations.

If the engine is poorly maintained and/or there are high concentrations of unburned fuel in the exhaust gases, over a period of time the catalytic converter can become inoperative due to thermal stress as it attempts to oxidize the excess hydrocarbons. Another cause of catalytic converter failure is the use of leaded fuel. The lead in the fuel will quickly render the catalysts ineffective. If either thermal stress or continued use of leaded fuel occurs, the tiny passageways in the ceramic substrate of the converter can become damaged (restricted), causing excessive exhaust backpressure.



1 CATALYTIC CONVERTER 2 MUFFLER 1 3 MUFFLER 2



Catalytic Converter and Exhaust System

GLOSSARY OF TERMS

Terms used in this manual are listed below in alphabetical order with an explanation.

ABSOLUTE PRESSURE - Uses a zero reference point of a total absolute vacuum. An absolute pressure gauge placed into an absolute vacuum would indicate "zero." If left unconnected in a room, the absolute pressure gauge would indicate the atmospheric pressure surrounding the gauge, approximately 100 kPa at sea level. This pressure reading would be a "barometric pressure" reading which will change at different altitudes or with various barometric pressure changes. When connected into an engine intake manifold, the absolute pressure gauge will indicate the "air pressure" in the intake manifold. With the engine stopped, this pressure reading will equal atmospheric pressure. When the engine is running it acts like a vacuum pump, and the intake manifold pressure will be less than the atmospheric pressure. This "engine running" pressure reading is dependent on throttle opening and engine speed.

AIR/FUEL RATIO - The amount of air compared to the amount of fuel in the air-fuel mixture. See also **STOICHIOMETRIC RATIO.**

ANALOG SIGNAL - An electrical signal that varies in voltage within a given range.

ASSEMBLY LINE DATA LINK - Used at the assembly plant to evaluate the engine management system, for service (to flash "Check Engine" light), use of Tech 1 diagnostic tool, and performing other system checks.

ASSEMBLY LINE DATA LINK DATA STREAM - An output of the electronic control module. This output is a digital computer-language signal used by assembly plant test equipment and the Tech 1 diagnostic tool. This signal is transmitted to the assembly line data link connector.

BAROMETRIC PRESSURE - Atmospheric pressure. May also be called BARO pressure.

CARBON MONOXIDE - One of the pollutants found in engine exhaust.

CHECK ENGINE LIGHT - Warning indicator with the outline of an engine, located in the instrument panel, and controlled by the electronic control module. Illuminated by the electronic control module when it detects a malfunction in the engine management system, or when the ignition is "ON" with the engine not running (bulb check).

COOLANT TEMPERATURE SENSOR - Device that senses the engine coolant temperature, and passes that information to the electronic control module.

CURRENT OR AMPERAGE - A measurement of the flow rate or amount of electricity. The rate of flow of electrons is similar to gallons of water per minute flowing in a water pipe.

DIAGNOSTIC CODE - See **SELF-DIAGNOSTIC CODE.**

DIAGNOSTIC DISPLAY MODE - An electronic control module mode of operation that is used to display stored codes on the "Check Engine" light. This mode is entered by grounding the assembly line data link terminal "B" when the ignition is "ON" and the ENGINE STOPPED - it is similar to the "Field Service" mode but with the engine not running.

DIAGNOSTIC "TEST" TERMINAL - "B" terminal of the assembly line data link connector, grounded to flash a trouble code on the "Check Engine" light.

DIAGNOSTIC TOOL - See Tech 1.

DIGITAL SIGNAL - An electrical signal that can only be either "ON" or "OFF."

DIGITAL VOLTMETER - Digital voltmeter with at least 10 million ohms per volt impedance—used for voltage and resistance measurement in electronic systems.

DIODE - An electrical device that restricts current flow in one direction.

DIRECT IGNITION SYSTEM - The direct ignition system does not use the conventional distributor and coil. This ignition system consists of an ignition module and crankshaft sensor in addition to the related connecting wires and the electronic control module. It is a very reliable and efficient system.

DRIVER - An electronic device, usually a power transistor, that operates like a switch; that is, it turns something "ON" or "OFF."

ELECTRONIC CONTROL MODULE - A metal cased box containing electronic circuitry which electrically monitors and controls air/fuel and emission systems on the engine management system, and turns "ON" the "Check Engine" light when a malfunction is detected in the system.

ELECTROMAGNETIC INTERFERENCE OR ELECTRICAL NOISE - An unwanted signal interfering with another needed signal; like an electric razor upsets a television picture, or driving under high voltage power lines cause static noise in the AM radio in a vehicle.

ELECTRONIC FUEL INJECTION - Electronic control module control of fuel delivery, which in this case utilizes a throttle body injection unit.

ELECTRONIC SPARK TIMING - Electronic control module controlled timing of ignition spark.

ENERGIZE/DE-ENERGIZE - When current is passed through a coil (energized) such as a solenoid, a plunger is pulled or pushed. When the voltage to the solenoid is turned "OFF," (de-energized), a spring raises or lowers the plunger.

ENGINE CALIBRATOR - A plug-in memory unit that instructs the electronic control module how to operate for a particular vehicle.

EVAPORATIVE EMISSIONS CONTROL SYSTEM - Used to prevent gasoline vapors in the fuel tank from entering the atmosphere. Stores the vapors in a storage canister located above the left front wheel well. The canister contains activated charcoal, and the vapors are "purged" by engine vacuum during certain operating conditions. This purging action is controlled by the electronic control module.

FIELD SERVICE MODE - An electronic control module mode of operation that is used during service. It is operational when the ENGINE IS RUNNING and the Assembly line data link diagnostic test terminal "B" is grounded.

FUEL INJECTION - Electronic control module fuel control using throttle body fuel injection.

HARD FAIL - A term used to indicate the electronic control module is presently detecting an existing malfunction, has turned "ON" the "Check Engine" light, and logged the malfunction code in memory.

HIGH - A voltage more than ground or 0. In digital signals, high is "ON" and low is "OFF."

HIGH IMPEDANCE VOLTMETER - Has high opposition to the flow of electrical current. Good for reading circuits with low current flow, such as found in electronic systems. Digital voltmeter meets these requirements while older analog "moving needle" meters do not.

HYDROCARBONS - One of the pollutants found in engine exhaust.

IDLE AIR CONTROL - Installed in the throttle body unit and controlled by the electronic control module to regulate idle air flow, and thus idle rotations per minute.

IDEAL MIXTURE - The air/fuel ratio which provides the best performance, while maintaining maximum conversion of exhaust emissions, typically 14.7/1 on Gasoline engines.

INPUTS - Information from sensors and switches used by the electronic control module to determine how to control its outputs.

INTAKE AIR TEMPERATURE SENSOR - The intake air temperature sensor is a thermistor located in the air cleaner housing. It monitors air temperature passing into the throttle body. The electronic control module uses this information in its fuel delivery calculations.

INTERMITTENT - Occurs now and then; not continuously. In electrical circuits, refers to occasional open, short, or ground.

INSTRUMENT PANEL (I/P) - Contains instrument gages and indicator lights to indicate performance of the vehicle.

KILOMETER PER HOUR - A metric unit measuring distance (1000 meters) in one hour.

LITER - A metric unit of capacity.

LOW - Electrically operates the same as a ground and may, or may not, be connected to chassis ground.

MALFUNCTION CODE - See SELF-DIAGNOSTIC CODE.

MANIFOLD ABSOLUTE PRESSURE SENSOR - Reads intake manifold pressure changes, similar to a vacuum gauge reading manifold vacuum, with pressure readings reversed from a vacuum gauge. See **ABSOLUTE PRESSURE.**

MERCURY- A calibration material used as a standard for vacuum or pressure measurement.

MODE - A particular state of operation.

NEWTON METERS (TORQUE) - A metric unit which measures force.

NORMALLY OPEN - Switch contacts that are not connected, or not together, when no outside forces (temperature, pressure, position) are applied.

NORMALLY CLOSED - Switch contacts that are connected, or together, when no outside forces (temperature, pressure, position) are applied.

NITROGEN, OXIDES OF - One of the pollutants found in engine exhaust. Nitrogen that combines with oxygen to form oxides of nitrogen.

OCTANE ADJUST POTENTIOMETER - An ignition timing adjustment potentiometer which is used as an input signal by the electronic control module. This is a "dealer only" adjustment which requires use of the Tech 1 diagnostic tool, and is used to define a spark retard condition which allows for low octane fuel.

OUTPUT - Functions, typically solenoids and relays, that are controlled by the electronic control module.

OXYGEN SENSOR - Monitors the oxygen content of the exhaust gases and generates a voltage signal to the electronic control module.

PORT FUEL INJECTION - Injection is controlled by the electronic control module to supply the precise air/fuel ratio. Fuel is injected at each cylinder near the intake valve.

PROGRAMMABLE READ ONLY MEMORY - An electronic term used to describe the engine calibration unit, and a part of the engine calibrator.

PULSE WIDTH MODULATED - A digital signal turned "ON" and "OFF" for a percentage of available "ON-plus-OFF" cycle time, such as 30% "ON" and 70% "OFF" would be called a 30% "ON" pulse width modulated signal.

QUAD DRIVER - A "chip" device in the electronic control module, capable of operating four separate outputs. Outputs can be either "ON-OFF" or pulse width modulated.

RESISTANCE - The ability of a circuit to limit current flow; like a restriction in a water pipe.

REVOLUTIONS PER MINUTE - A measure of engine rotation speed.

SCAN TOOL - See Tech 1.

SELF-DIAGNOSTIC CODE - Also known as "trouble code," or "malfunction code." The electronic control module can detect malfunctions in the engine management system. If a malfunction occurs, the electronic control module turns "ON" the "Check Engine" light, and a two-digit code number will set in the electronic control module's memory.

A diagnostic code can be obtained from the electronic control module through the "Check Engine" light, or with the Tech 1 diagnostic tool. This code will indicate the area of the malfunction. Properly following the workshop manual diagnostic procedures for the engine management system will locate the source of the problem. *NOTE: Code 12 is NOT a trouble code, but does verify that the electronic control module's diagnostic ability is operational.* Code 12 means "no crankshaft reference signal," which is normal when the engine is not running.

STOICHIOMETRIC RATIO - The ideal air fuel ratio when all of the air and all of the fuel is burned in the cylinder. The stoichiometric ratio is the best compromise between a rich air-fuel ratio for best power, and a lean air-fuel ratio for best economy. Also called the Ideal Air-Fuel Ratio.

For Pure Gasoline vehicles the ideal air fuel ratio is 14.7/1.

TACHOMETER - A device for indicating speed for rotation.

TECH 1 (ALSO CALLED TECH 1 SCAN TOOL OR TECH 1 DIAGNOSTIC TOOL) - A hand-held diagnostic tool, containing a microprocessor to interpret the electronic control module's assembly line data link data stream. A display panel displays the electronic control module's input signals and output commands. The Tech 1 is CRUCIAL for diagnosis and servicing of the fuel injection system.

THROTTLE BODY INJECTION UNIT - Is controlled by the Electronic control module to supply precise air/fuel mixture into the intake manifold. The throttle body injection unit is a single point fuel injection unit. It contains one fuel injector centrally located above the throttle valve. The unit is mounted on the intake manifold and replaces the conventional carburetor. It also contains the fuel pressure regulator, throttle position sensor, and idle air control device which regulates idle speed.

THROTTLE POSITION SENSOR - Device that tells the electronic control module the current throttle position, and when it is moving, the rate of throttle opening/closing.

TROUBLE CODE - See **SELF-DIAGNOSTIC CODE**

VACUUM, MANIFOLD - Vacuum source is the engine.

VACUUM, PORTED - Vacuum source from a small "port" in the throttle body. With the throttle closed, there would be no vacuum measured, because the port is on the air cleaner side of the throttle blade, and is exposed to engine vacuum only after the throttle is open.

VEHICLE IDENTIFICATION NUMBER - Appears on a plate attached to the dash.

VEHICLE SPEED SENSOR - A "Hall Switch" device that sends signal pulses to the electronic control module to be interpreted as vehicle speed (road speed).

VOLT - A measurement of electrical pressure.

VOLTAGE - The pressure of force pushing the current in a circuit; like pressure in a water pipe.

WIDE OPEN THROTTLE - Refers to the throttle valve or accelerator pedal when fully open or depressed.

1.1 ELECTRONIC CONTROL MODULE AND SENSORS

ELECTRONIC CONTROL MODULE

The electronic control module (Figures 1.1-1 and 1.1-2), located behind the front left footspace trim panel, is the control center of the fuel injection system. It constantly monitors information from various sensors, and controls the systems that affect exhaust emissions and vehicle performance. The electronic control module performs the diagnostic function of the system. It can recognize operational problems, alert the driver through a "Check Engine" light, and store a code(s) which identifies problem areas to aid the technician in making repairs. See "Diagnosis," Section "2" for more information on using the diagnostic functions of the electronic control module.

The electronic control module supplies either 5, 8, or 12 volt signal voltages to various sensors or switches. This is done through resistances in the electronic control module which are so high in value that a test light will not light when connected to the circuit. In most cases, an ordinary shop voltmeter will not give an accurate reading because the meter's internal resistance is too low. ***A 10 Million Ohm input impedance digital voltmeter is required to assure accurate voltage readings.*** See "Special Tools," Section "6."

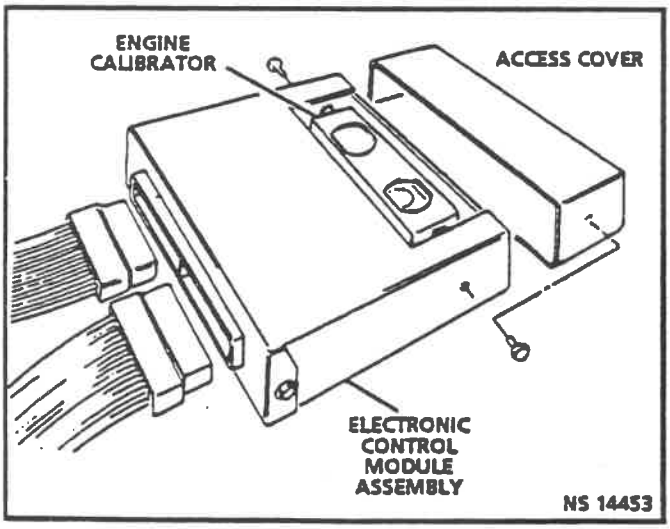


Figure 1.1-1 - Electronic Control Module

ELECTRONIC CONTROL MODULE FUNCTION

The electronic control module controls output circuits such as the fuel injector, electronic spark timing system, idle air control, and various relays by controlling the ground circuit through transistors in the electronic control module. The only exception to this is the fuel system relay control circuit. The fuel system relay is the only electronic control module-controlled circuit where the electronic control module controls the +12 volts sent to the coil of the relay. The ground side of the fuel system relay coil is connected to engine ground.

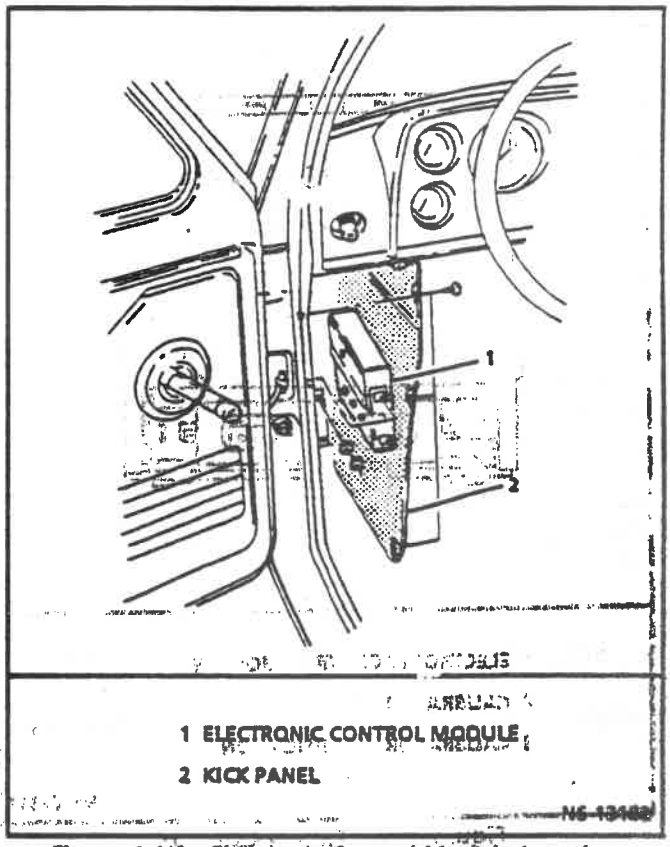


Figure 1.1-2 - Electronic Control Module Location

ENGINE CALIBRATOR

To allow one model of electronic control module to be used for different vehicles, a device called an "Engine Calibrator" unit is used (see Figure 1.1-3).

The engine calibrator is located inside the electronic control module and has information on the vehicle's weight, engine, transmission, axle ratio and several other factors. While one electronic control module part number may be used by different vehicles, an engine calibrator is specific. For this reason, it is very important to check the latest parts catalog and Technical Information Bulletin for the correct part number when replacing an engine calibrator.

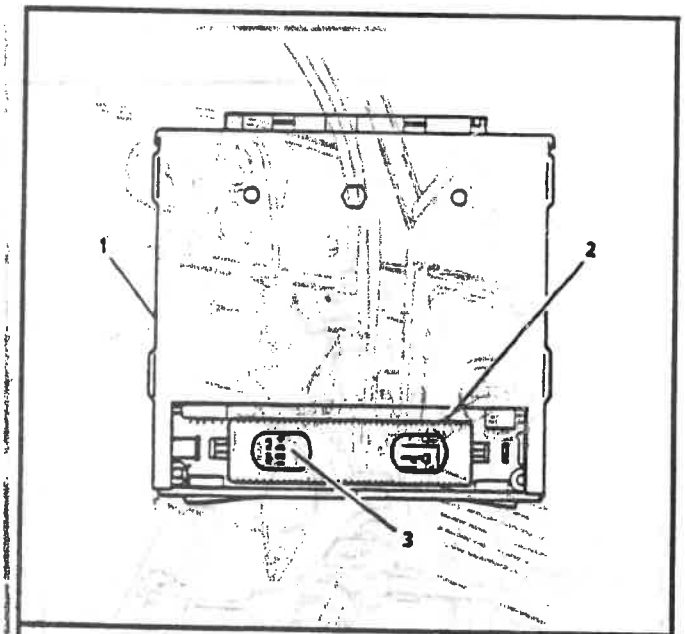


Figure 1.1-3 - Engine Calibrator

MEMORY

There are three types of memory storage within the electronic control module: Read only memory, random access memory, and programmable read only memory.

Read Only Memory

Read only memory is a permanent memory that is contained within the engine calibrator assembly, which is removable from the electronic control module. The read only memory contains the overall computer program, called "control algorithms" and is the set of operating instructions. Because it contains the control algorithms, the electronic control module cannot function without the calibrator installed.

Once the read only memory is programmed, it cannot be altered. The read only memory is nonvolatile, and does not need power to be retained.

Random Access Memory

Random Access Memory is the "scratch pad" portion of the microprocessor, which is located on the circuit board of the electronic control module. Random access memory is generally used to calculate and temporarily store values that will be used in other calculations. The microprocessor can write into, or read from this memory as needed. This memory is volatile and needs a constant supply of voltage to be retained. If the voltage is lost, any stored trouble codes and calculated values are erased.

Programmable Read Only Memory

Programmable read only memory contains the different engine calibration information that is specific to vehicle model, and emission regulations to be satisfied. The programmable read only memory is only read, or used, by the electronic control module. The programmable read only memory is nonvolatile, and does not need power to be retained.

The programmable read only memory is contained within the engine calibrator assembly and is removable from the electronic control module. The engine calibrator should be retained with the vehicle following electronic control module replacement.

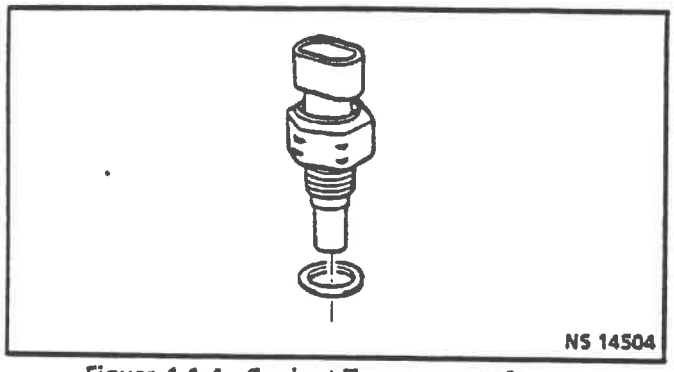


Figure 1.1-4 - Coolant Temperature Sensor

INFORMATION SENSORS

Coolant Temperature Sensor
Figures 1.1-4 and 1.1-5

The coolant temperature sensor is a thermistor (a resistor which changes resistance based on temperature) mounted in the engine coolant stream. The thermistor inside the sensor is a "negative temperature coefficient" thermistor. That is, its resistance goes down as it gets hotter. High temperature causes low resistance (70 ohms at 130°C), while low coolant temperature produces a high resistance (100,700 ohms at -40°C).

The electronic control module supplies a 5 volt signal to the coolant temperature sensor through a fixed value resistor inside the electronic control module. By measuring the voltage drop across the variable resistance sensor, the electronic control module calculates the engine coolant temperature. The voltage will be high when the engine is cold, and low when the engine is hot. Engine coolant temperature affects most systems the electronic control module controls.

If a problem occurs in the coolant temperature sensor circuits, after a period of time the electronic control module will store a code in its memory and turn on the "Check Engine" light, indicating there is a problem. If this occurs, the electronic control module will calculate a "substitute" coolant temperature, based on either the signal from the intake air temperature sensor, or a substitute value stored in the electronic control module's memory.

A failure in the coolant temperature sensor circuits should set either a Code 14 or 15. Remember, these codes indicate a failure in the circuit, so proper use of the diagnostic chart will lead to either repairing a wiring problem or replacing the sensor to properly repair a problem.

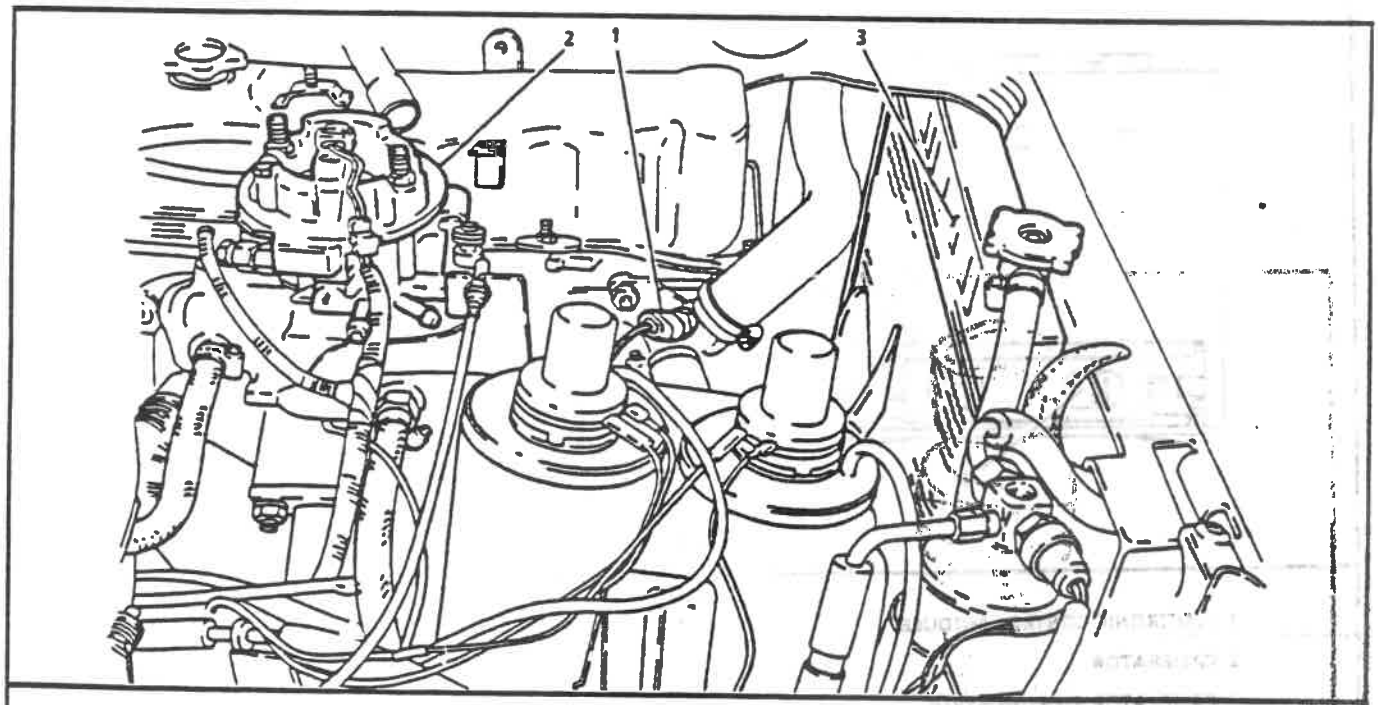


Figure 1.1-5 - Coolant Temperature Sensor Location View

Intake Air Temperature Sensor
Figures 1.1-6 and 1.1-7

The intake air temperature sensor is a thermistor (a resistor which changes value based on temperature) mounted in the bottom of the air cleaner, on the 1.7L engine. The thermistor inside the sensor is a "negative temperature coefficient" thermistor. That is, its resistance goes down as it gets hotter. High temperature causes low resistance (70 ohms at 130°C), while low air temperature produces a high resistance (100,700 ohms at -40°C).

The electronic control module supplies a 5 volt signal to the intake air temperature sensor through a fixed value resistor inside the electronic control module. By measuring the voltage drop across the variable resistance sensor, the electronic control module calculates the intake air temperature. The voltage will be high when the air is cold, and low when the air is hot.

Intake air temperature affects most systems the electronic control module controls.

If a problem occurs in the intake air temperature sensor circuits, after a period of time the electronic control module will store a code in its memory and turn on the "Check Engine" light, indicating there is a problem.

If this occurs, the electronic control module will calculate a "substitute" intake air temperature, based on either the signal from the coolant temperature sensor, or a substitute value stored in the electronic control module's memory.

A failure in the intake air temperature sensor circuits should set either a Code 23 or 25. Remember, these codes indicate a failure in the circuit, so proper use of the diagnostic chart will lead to either repairing a wiring problem or replacing the sensor, to properly repair a problem.

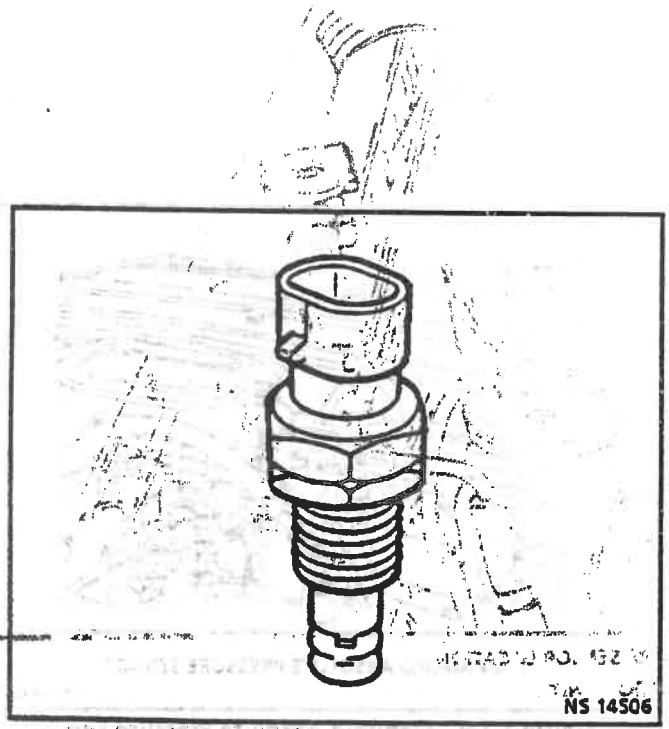


Figure 1.1-6 - Intake Air Temperature Sensor

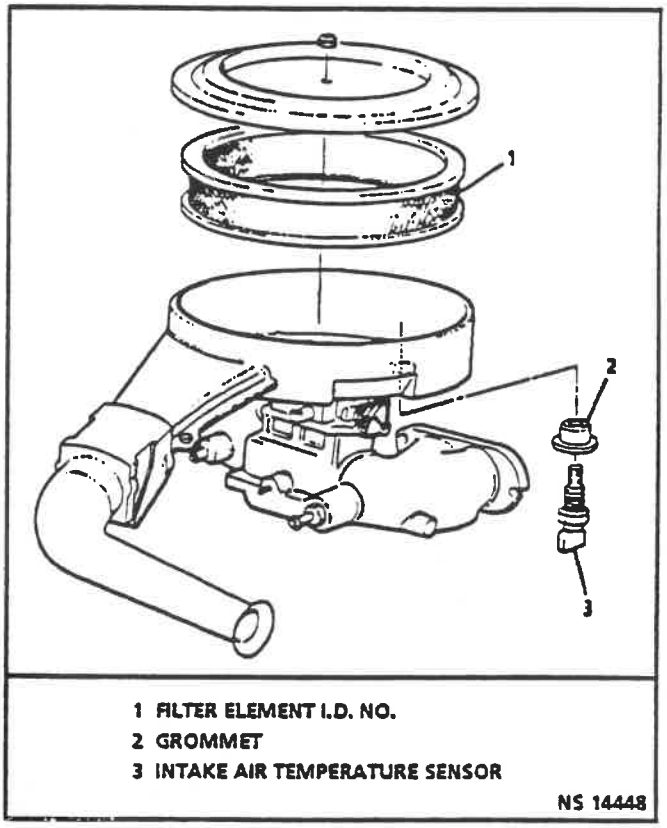


Figure 1.1-7 - Intake Air Temperature Sensor Location View

Manifold Absolute Pressure Sensor
Figures 1.1-8 and 1.1-9

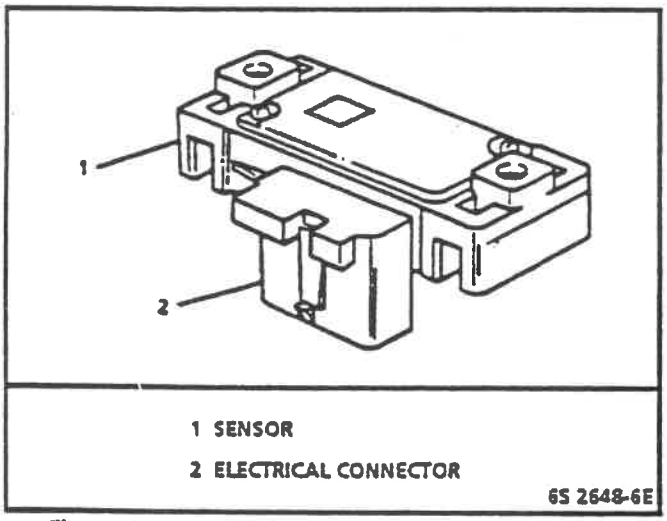
To understand this sensor's operation, it is first required to understand the principle of absolute pressure measurement.

Most pressure gauges, when not connected to anything, indicate a "zero" reading. However, there is actually an atmospheric pressure surrounding the gauge. If an *absolute* pressure gauge is observed when not connected to anything, its reading would be about 100 kPa, or 1 bar, at sea level. That is because an absolute pressure gauge's "zero" point is an absolute vacuum, or the total absence of any pressure.

To further this explanation, absolute pressure measurement uses the zero reference point of a total absolute vacuum. An absolute pressure gauge would read "zero" only when placed into a vacuum chamber evacuated to an absolute, total vacuum. Any "pressure" above this absolute vacuum reference point will indicate a positive pressure. If left unconnected in a room, the absolute pressure gauge would indicate the atmospheric pressure surrounding the gauge, approximately 100 kPa at sea level. This pressure reading would be a "barometric" pressure reading which will change at different altitudes or with changes in barometric pressure.

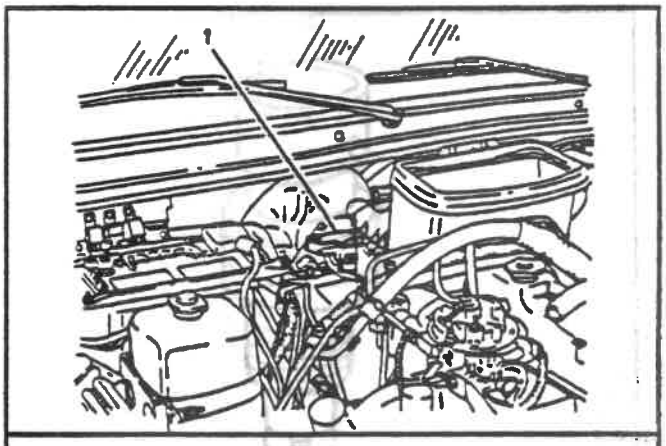
When connected into an engine's intake manifold, the absolute pressure gauge will indicate the absolute pressure inside the manifold. With the engine stopped, this pressure reading will equal atmospheric pressure. With the engine running, its pumping action acts like a vacuum pump, and the intake manifold pressure will be less than atmospheric pressure. This "engine running" pressure reading is dependent on throttle opening and engine speed.

By using an absolute pressure gauge, the electronic control module can monitor for atmospheric pressure changes that normally occur with barometric pressure changes and/or changes in altitude. This "barometric" pressure is measured when the ignition is first turned "ON," before the engine begins cranking. The electronic control module can also "update" this barometric pressure reading during engine operation, when the throttle is nearly wide open at low engine speed.



1 SENSOR
2 ELECTRICAL CONNECTOR
6S 2648-6E

Figure 1.1-8 - Manifold Absolute Pressure Sensor



1 MANIFOLD ABSOLUTE PRESSURE SENSOR
NS 14520

Figure 1.1-9 - Manifold Absolute Pressure Sensor Location View

The manifold absolute pressure sensor (Figure 1.1-8 and 1.1-9), is a pressure transducer that measures the changes in the intake manifold pressure. A small hose connecting the sensor to the intake manifold (or throttle body) allows the sensor to measure the absolute pressure inside the manifold. The pressure changes as a result of engine load and speed change, and the manifold absolute pressure sensor converts this to a voltage output signal.

The electronic control module sends a 5 volt reference voltage to the manifold absolute pressure sensor. As the manifold pressure changes, the 0-5 (zero to five) volt output signal of the sensor also changes in direct relation to the pressure.

A closed throttle on engine coastdown would produce a relatively low manifold absolute pressure output voltage, while a wide-open throttle would produce a high manifold absolute pressure output voltage. This high output voltage is produced because when the throttle is wide open, the pressure inside the manifold is nearly the same as atmospheric pressure.

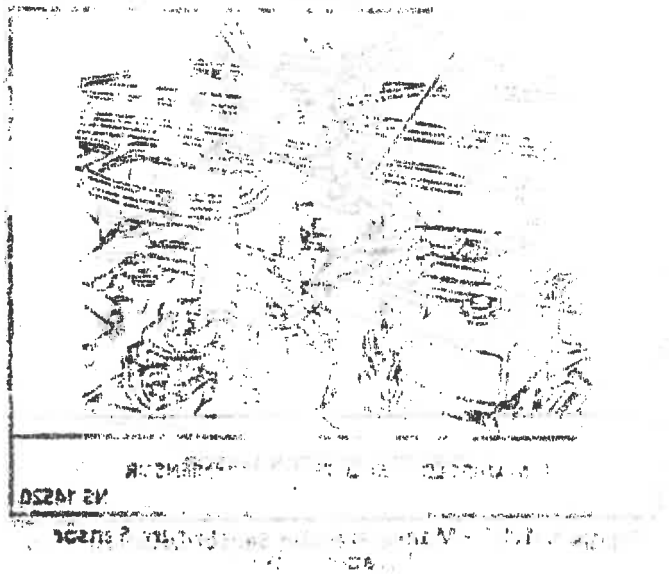
By monitoring the sensor's output signal, the electronic control module calculates the manifold pressure. A higher pressure requires more fuel, while a lower pressure requires less fuel.

The electronic control module uses the manifold absolute pressure sensor signal as one of its most important input signals to control fuel delivery and ignition timing.

If a problem occurs in the manifold absolute pressure sensor circuits, after a period of time the electronic control module will store a code in its memory and turn on the "Check Engine" light, indicating there is a problem. If this occurs, the electronic control module will calculate a "substitute" manifold pressure, based on engine speed and throttle opening.

A failure in the manifold absolute pressure sensor circuits should set either a Code 33 or 34. Remember, these codes indicate a failure in the *circuit*, so proper use of the diagnostic chart will lead to either repairing a wiring problem or replacing the sensor, to properly repair a problem.

The table below shows the relationship of absolute pressure values to the sensor's output signal.



Atmospheric pressure at sea level ↓ — Absolute vacuum ↓

BAR	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
kPa	100	90	80	70	60	50	40	30	20	10	0
V	4.9	4.4	3.8	3.3	2.7	2.2	1.7	1.1	0.6	0.3	0.3

↑ Sensor output signal voltage

5-11-92
NS 14975

Absolute Pressure Values to Sensors Output Signals Relationship Table

Throttle Position Sensor
Figures 1.1-10 and 1.1-11

The throttle position sensor is mounted on the side of the throttle body opposite the throttle lever assembly. Its function is to sense the current throttle valve position and relay that information to the electronic control module. Knowledge of throttle position is needed by the electronic control module to calculate the injector control signals (pulses). Should the throttle position sensor sense a wide open throttle, a voltage signal indicating this is sent to the electronic control module. The electronic control module will then widen the injector pulses, permitting increased fuel flow.

As the throttle valve rotates in response to movement of the accelerator pedal, the throttle shaft transfers this rotational movement to the throttle position sensor. When this occurs, the throttle position sensor output voltage changes. The electronic control module will use a rapidly increasing throttle position sensor signal voltage as an indication of increased fuel requirements, signaling the electronic control module to add extra injector control pulses. This simulates an accelerator pump in a carburetor.

The sensor is a potentiometer type of resistor, with one end connected to a 5 volt reference voltage from the electronic control module, and the other end to electronic control module ground. A third wire connects from a movable contact in the throttle position sensor to the electronic control module, allowing the electronic control module to measure the signal voltage from the throttle position sensor.

As the throttle is moved (accelerator pedal moved), the output signal from the movable contact inside the throttle position sensor changes. At a closed throttle position, the output of the throttle position sensor is below 1.25 volts. As the throttle valve opens, the output increases so that at a wide-open throttle position, the output voltage should be above 4 volts.

By monitoring the output voltage from the throttle position sensor, the electronic control module can determine the present throttle valve angle (driver demand). By monitoring for a *changing* voltage, the electronic control module can determine if the throttle valve is either opening or closing. A broken or loose throttle position sensor can cause intermittent bursts of fuel from the injector, and an unstable idle, because the electronic control module would calculate that the throttle is moving.

If a problem occurs in the throttle position sensor circuits, after a period of time the electronic control module will store a code in its memory and turn on the "Check Engine" light, indicating there is a problem. If this occurs, the electronic control module will calculate a "substitute" throttle position, based on engine speed.

A failure in the throttle position sensor circuits should set either a Code 21 or 22. Remember, these codes indicate a failure in the *circuit*, so proper use of the diagnostic chart will lead to either repairing a wiring problem or replacing the sensor, to properly repair a problem.

The throttle position sensor is not adjustable. The electronic control module uses the lowest signal voltage reading at idle for the zero reading (0% throttle), so no adjustment is necessary.

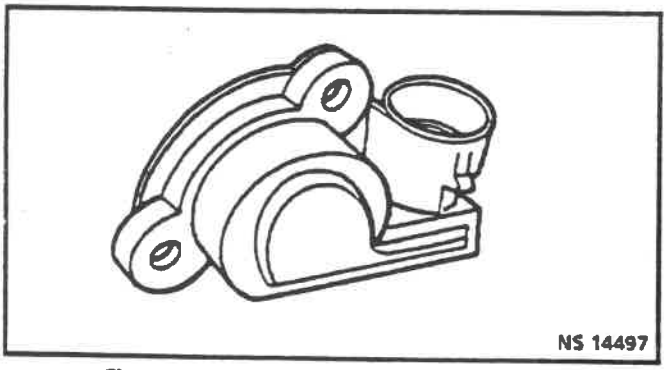


Figure 1.1-10 - Throttle Position Sensor

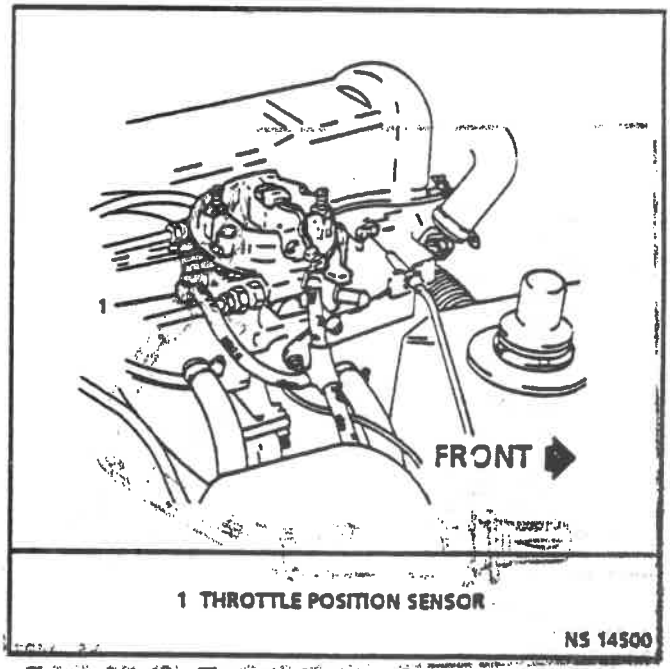


Figure 1.1-11 - Throttle Position Sensor Location View

Oxygen Sensor (Electrically Heated)
Figures 1.1-12 and 1.1-13

For the most efficient emissions control, the best air/fuel mixture for a gasoline fueled engine is 14.6–14.7:1. This is called the "stoichiometric" ratio. With this combination of air and fuel, the catalytic converter is very efficient at reducing amounts of hydrocarbons, carbon monoxide, and oxides of nitrogen coming out of the engine's exhaust. In order to keep the exhaust gases optimized so that the catalytic converter is in its most efficient operating range, a closed loop fuel control system is used.

The electronic control module initially calculates the fuel injector pulsewidth from other input signals, such as manifold absolute pressure, engine speed and coolant temperature, intake air temperature, and so on. After the fuel is injected into the engine, the exhaust gas oxygen sensor signal can be used to adjust or correct the fuel injector pulsewidth calculations.

The exhaust gas oxygen sensor is the key to *"Closed-Loop"* fuel control. This sensor is what allows the fuel injection control system to give a "Closed Loop" "feedback" signal to the electronic control module, as to how accurate its fuel injector pulsewidth calculations were. The electronic control module uses information from the oxygen sensor to precisely fine-tune its fuel injector pulsewidth calculations, based on the unused, "left-over" oxygen content in the exhaust.

The oxygen content in the exhaust reacts with the oxygen sensor to produce a voltage output, similar to a variable-voltage battery. This signal voltage could be thought of like a type of gauge, ranging from approximately 0.1 volt (high oxygen content - lean exhaust) to 0.9 volt (low oxygen content - rich exhaust).

Because the sensor acts like a gauge, it is only indicating how rich or lean the exhaust is. The sensor does not cause things to happen, it only indicates what has already happened.

The sensor is mounted in the exhaust manifold, with the sensing portion exposed to the exhaust gas stream. When the sensor has reached an operating temperature of more than 360°C, it acts as a voltage generator, producing a rapidly changing voltage of between 10 - 1000 millivolts. This voltage output is dependent on the oxygen content in the exhaust gas, as compared to the sensor's atmospheric oxygen reference cavity. This reference cavity is exposed to the atmosphere through a small "vent" hole located under the sensor's external metal vent cover.

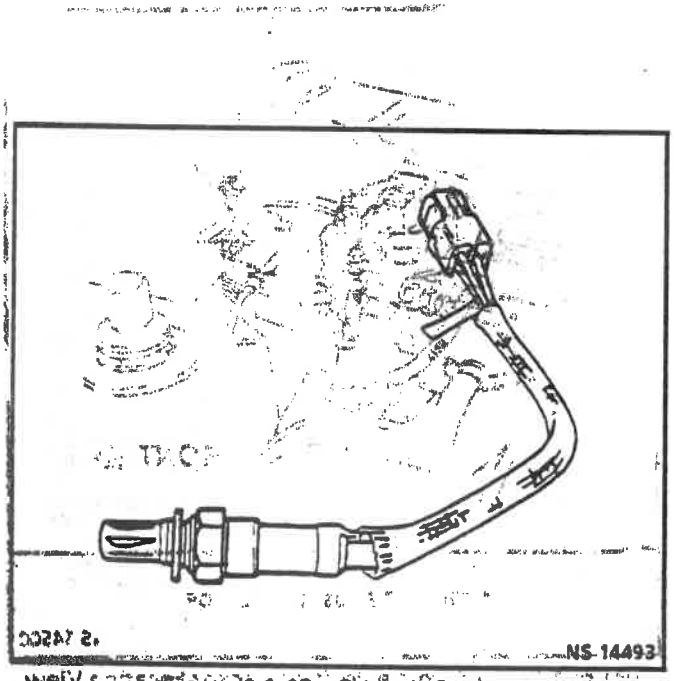


Figure 1.1-12 - Oxygen Sensor

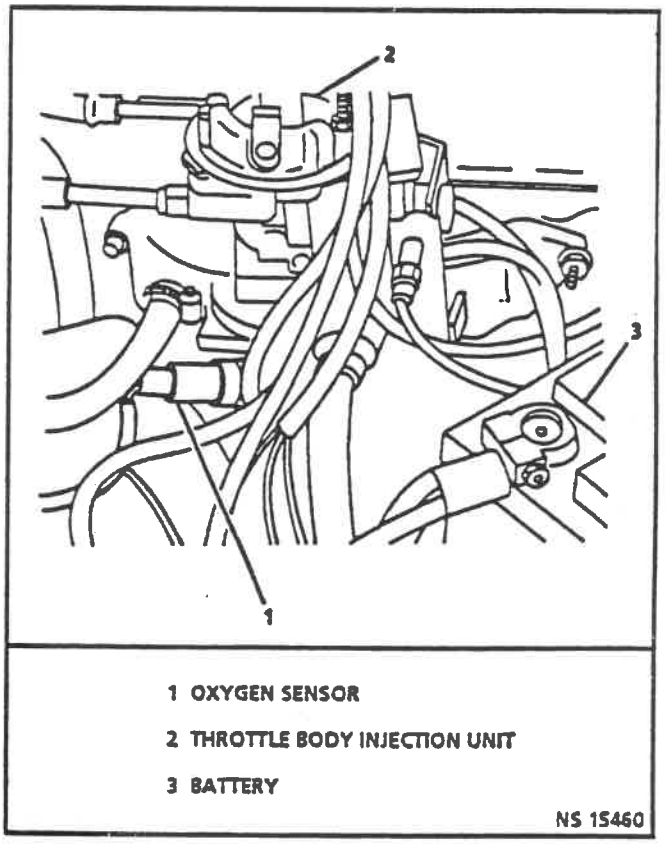


Figure 1.1-13 - Oxygen Sensor Location View

(Refer to Following Page for Additional Information When Reading Text Below)

When the sensor is cold, it produces either no voltage, or an unusable, slowly changing one. Also when cold, its internal electrical resistance is extremely high—many million ohms.

Because the sensor must be at least 360°C to operate effectively, it is equipped with an internal electric heating element to quickly heat the sensor after starting the engine. This heating element is powered from the vehicle's electrical system, any time the ignition is "ON."

The electronic control module always supplies a steady 450 millivolt, very low current "reference" voltage to the oxygen sensor circuit. When the sensor is cold and not producing any voltage, the electronic control module "sees" only this steady reference voltage. As the sensor begins heating and the engine is running, its internal resistance decreases and it begins producing a rapidly changing voltage that will overshadow the electronic control module-supplied steady reference voltage. When the electronic control module "sees" the changing voltage, it knows the sensor is hot and its output is ready to be used for the "fine-tuning" job. The electronic control module monitors the "changing," or going above and below a mid-range voltage band (approximately 300–600 millivolts), to help decide when to operate in the closed-loop mode. The Tech 1 diagnostic tool can display this ready status as **"OXYGEN SENSOR READY—NO / YES."**

When the fuel system is correctly operating in the closed-loop mode, the sensor voltage output is rapidly changing several times per second, going above and below a rich/lean "switch point."

Oxygen Sensor Poisoning

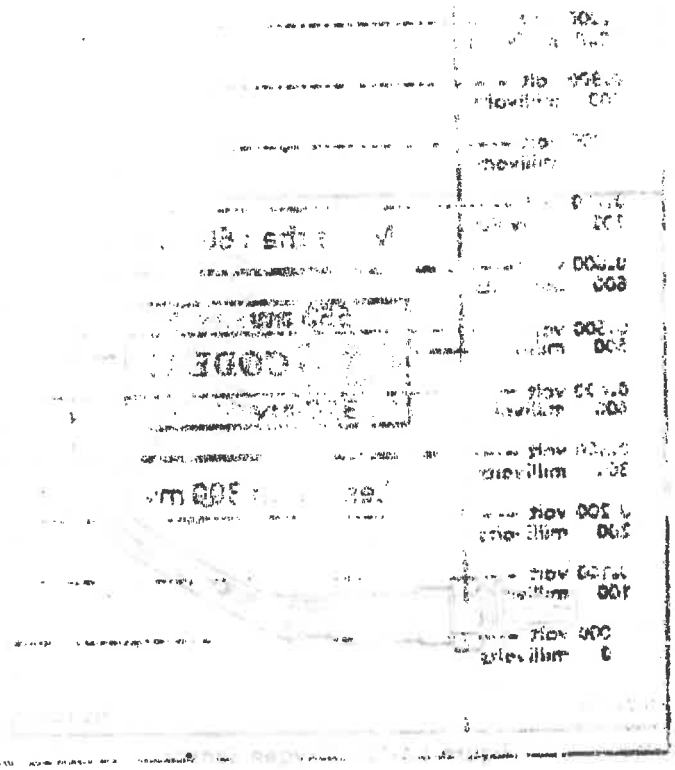
Oxygen sensors can be poisoned by either the use of leaded fuel, or assembling the engine parts with room temperature vulcanizing gasket sealer containing high amounts of high-volatility silicon. If the silicon volatility of a gasket sealer is very high, the silicon vapors will be drawn into the crankcase ventilation system, and introduced into the combustion process. These two elements, lead and silicon, can render the oxygen sensor inoperative over a period of time.

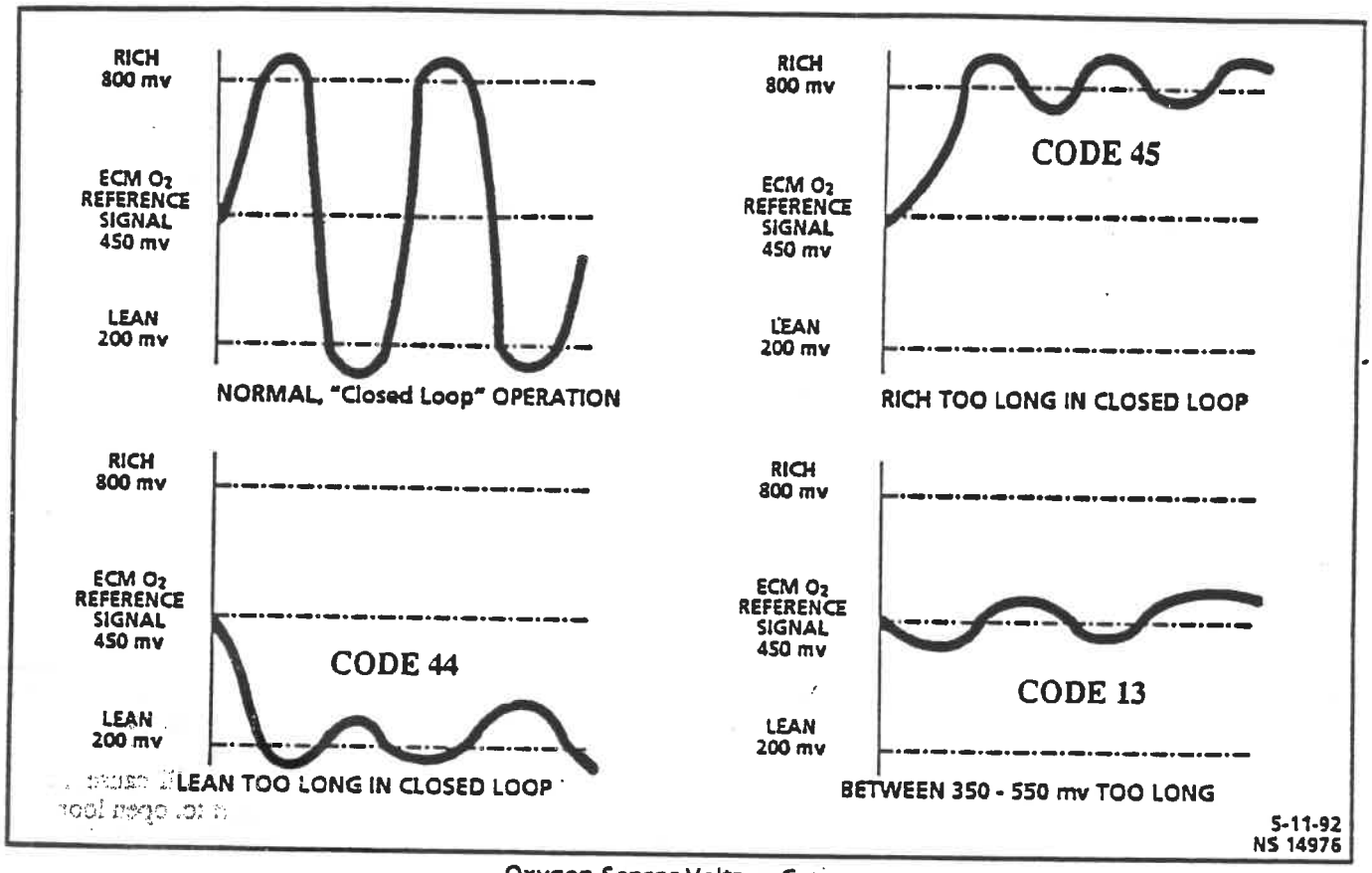
If the oxygen sensor circuitry has an open sensor signal circuit or ground circuit, or a defective, contaminated, or cold sensor, it could cause the signal voltage to stay within a 350–550 millivolt band too long, keeping the fuel control system in open-loop and storing a Code 13.

If the electronic control module receives a signal voltage indicating the exhaust gases have been lean for a long time, a Code 44 will store in the memory. One cause of a lean exhaust indication could include air leaks in the exhaust manifold or gasket, or low fuel pressure. A *false* indication of a lean exhaust could also include a grounded signal circuit between the oxygen sensor and the electronic control module.

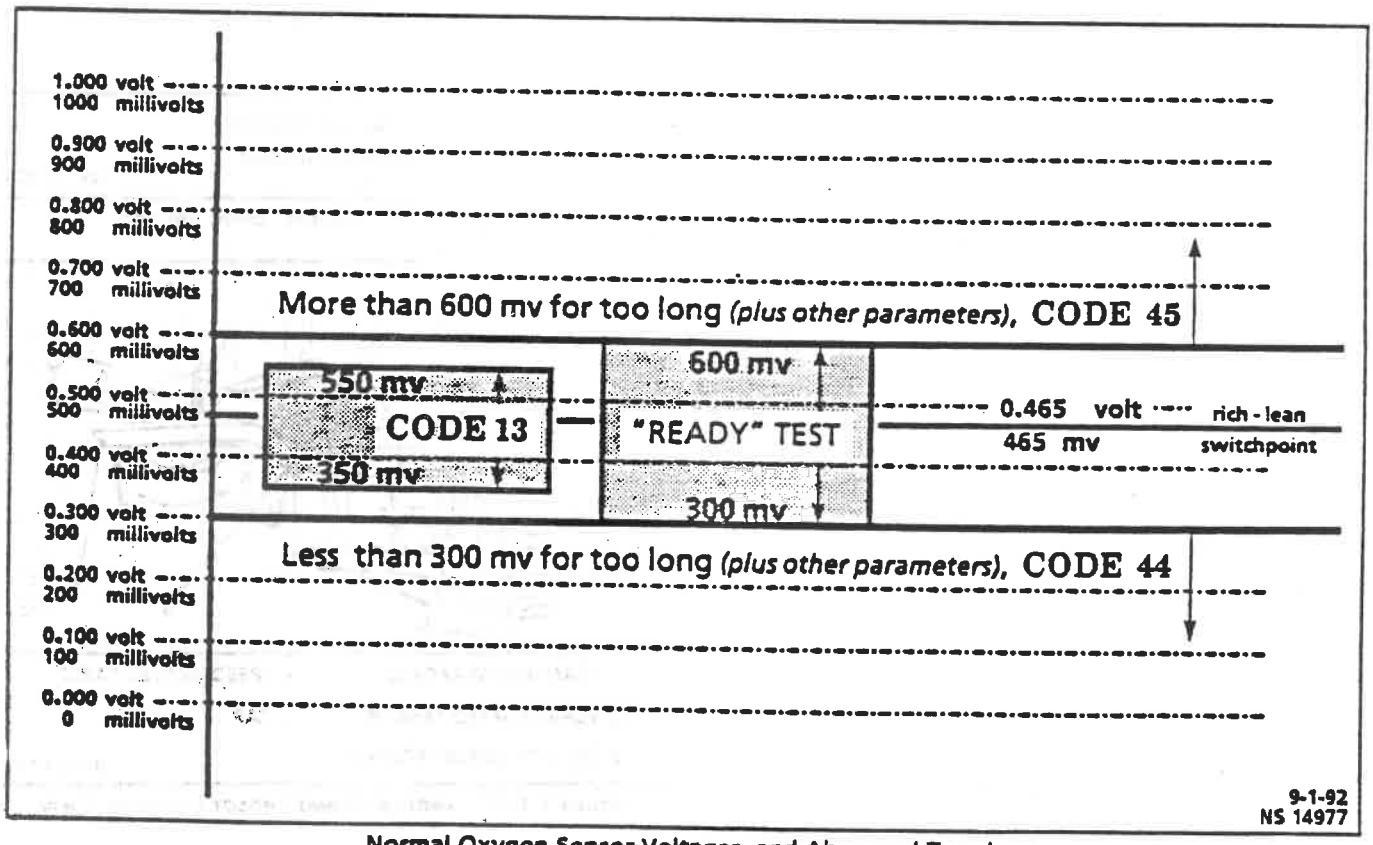
If the electronic control module receives a signal voltage indicating the exhaust gases have been rich for a long time, a Code 45 will store in the memory. One cause of a rich exhaust indication could include high fuel pressure. A *false* indication of a rich exhaust could also include a signal circuit between the oxygen sensor and the electronic control module that has somehow become connected to another voltage source.

Any of the Codes 13, 44, or 45 will cause the fuel control system to remain in, or revert to, open loop operation.





Oxygen Sensor Voltage Curves



Normal Oxygen Sensor Voltages, and Abnormal Trends

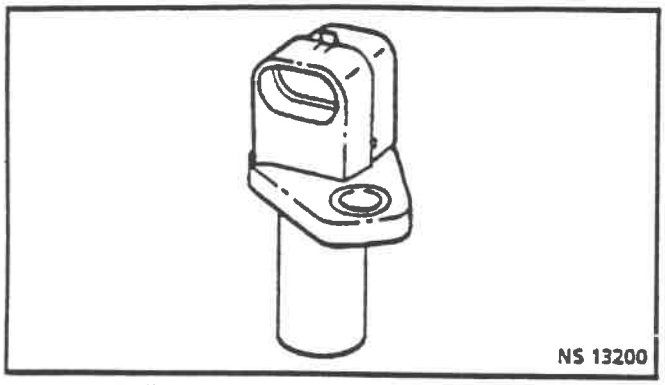


Figure 1.1-14 - Crankshaft Sensor

Crankshaft Position Reference Signal
Figures 1.1-14 and 1.1-15

The ignition system sends this signal to the electronic control module to tell it engine speed and crankshaft position. This signal is a repeating series of low voltage electrical pulses generated by the ignition module.

The electronic control module initiates fuel injector pulses based on the crankshaft reference signal pulses.

If a problem occurs in the crankshaft reference signal circuit from the ignition module to the electronic control module, the engine will not run. The electronic control module must receive this signal to initiate any fuel injector pulses. If the signal is absent, no fuel injector pulses will be sent to the injector. Proper diagnosis of this problem is fully explained in Section 2 of this manual, titled "Diagnostics." As explained in Section 2, all system diagnosis begins with the "Diagnostic Circuit Check."

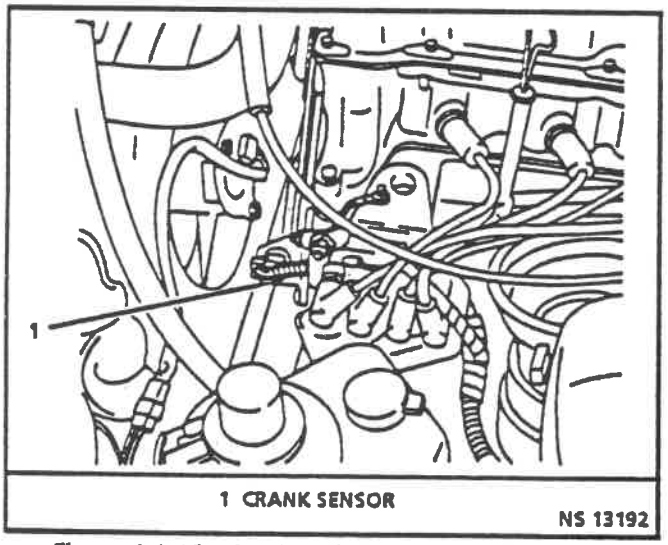


Figure 1.1-15 - Crankshaft Sensor Location View

Vehicle Speed Sensor
Figures 1.1-16 and 1.1-17

The vehicle speed sensor is a pulse type input that informs the electronic control module at what road speed the vehicle is being driven. The vehicle speed sensor system uses a Hall Switch to send electrical pulses to the electronic control module. The sensor is mounted at the output shaft of the transfer gear case to produce a frequency proportional to the speed of the drive wheels. This sensor assists in controlling the idle air control.

If a problem occurs in the vehicle speed sensor circuits, after a period of time the electronic control module will store a Code 24 in its memory, and turn "ON" the "Check Engine" light, indicating there is a problem. Remember, this code indicates a failure in the *circuit*, so proper use of the diagnostic chart will lead to either repairing a wiring problem or replacing the sensor to properly repair a problem.

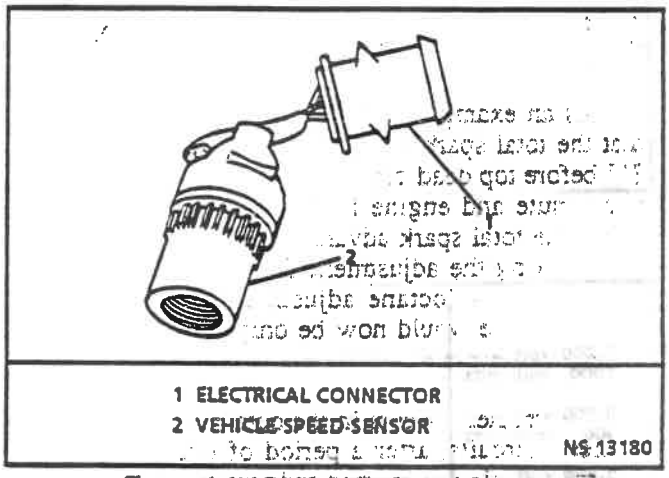


Figure 1.1-16 - Vehicle Speed Sensor

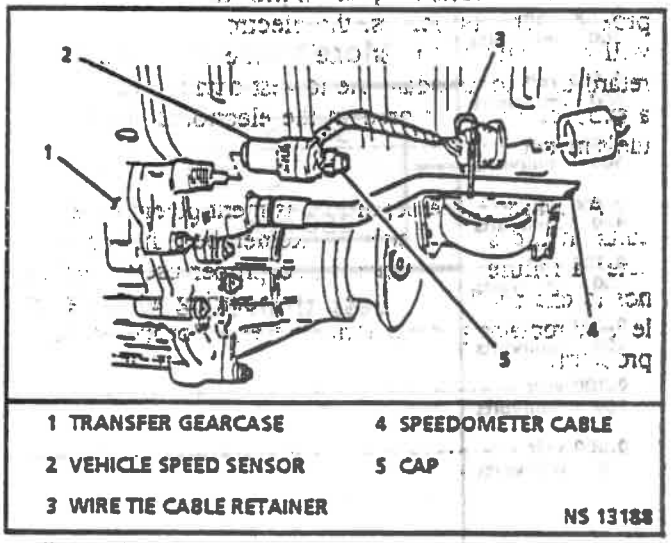


Figure 1.1-17 - Vehicle Speed Sensor Location View

OCTANE ADJUSTMENT
Figures 1.1-18 and 1.1-19

The octane adjustment potentiometer is a spark adjust input signal which is used by the electronic control module to select a spark retard condition to allow for the use of low octane fuel. This is a "dealer only" adjustment, and can only be adjusted with the use of the Tech 1 diagnostic tool.

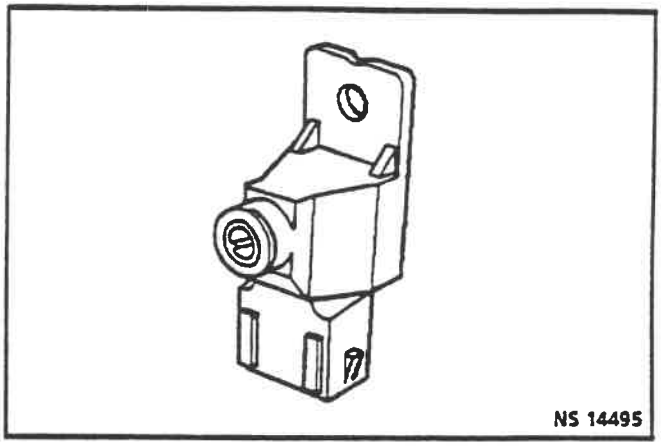
When the vehicle is assembled, this adjustment is usually set to a "no retard" value, shown on the Tech 1 diagnostic tool F0: data list parameter "octane adjust" as "0°". This will mean that the octane adjustment potentiometer has been adjusted for premium octane fuel, and the appropriate values for spark advance will be used.

If a lower octane fuel is to be used, the dealer would use the Tech 1 diagnostic tool to adjust the potentiometer for some appropriate value of less spark advance, to compensate for the low octane fuel. The display on the Tech 1 will show negative numbers as the potentiometer has been turned further away from its initial setting of 0°.

As an example for explanation purposes, let's say that the total spark advance for premium octane fuel is 35° before top dead center at some specified revolutions per minute and engine load. If a mechanic wanted to adjust the total spark advance for 8° less total advance, after making the adjustment using the Tech 1, the tool would display "octane adjustment" of –8°, and total spark advance would now be only 27° before top dead center.

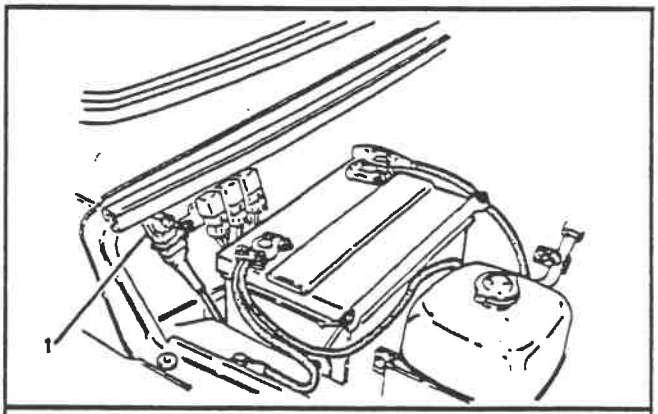
If a problem occurs in the octane adjustment potentiometer circuits, after a period of time the electronic control module will store a code in its memory and turn "ON" the "Check Engine" light, indicating there is a problem. If this occurs, the electronic control module will calculate a "substitute" value of ignition timing retard to accommodate the lowest octane fuel, based on a substitute value stored in the electronic control module's memory.

A failure in the octane adjustment potentiometer circuits should set a Code 54. Remember, this code indicates a failure in the *circuit*, so proper use of the diagnostic chart will lead to either repairing a wiring problem or replacing the potentiometer, to properly repair a problem.



NS 14495

Figure 1.1-18 - Octane Adjustment Potentiometer



1 OCTANE ADJUST POTENTIOMETER

NS 13198

Figure 1.1-19 - Octane Adjust Potentiometer Location View

Air Conditioning Request Signal

When received, this signal tells the electronic control module that the driver wants the air conditioning to operate. The signal originates at the instrument panel air conditioning switch, but must pass through several temperature and pressure switches before arriving at the electronic control module. The electronic control module uses this signal to ① adjust the idle air control position to compensate for the additional load placed on the engine by the air conditioning compressor, and then ② energizes the air conditioning control relay, to operate the air conditioning compressor.

1.2 FUEL CONTROL SYSTEM

GENERAL DESCRIPTION

The basic function of the fuel control system is to control fuel delivery to the engine.

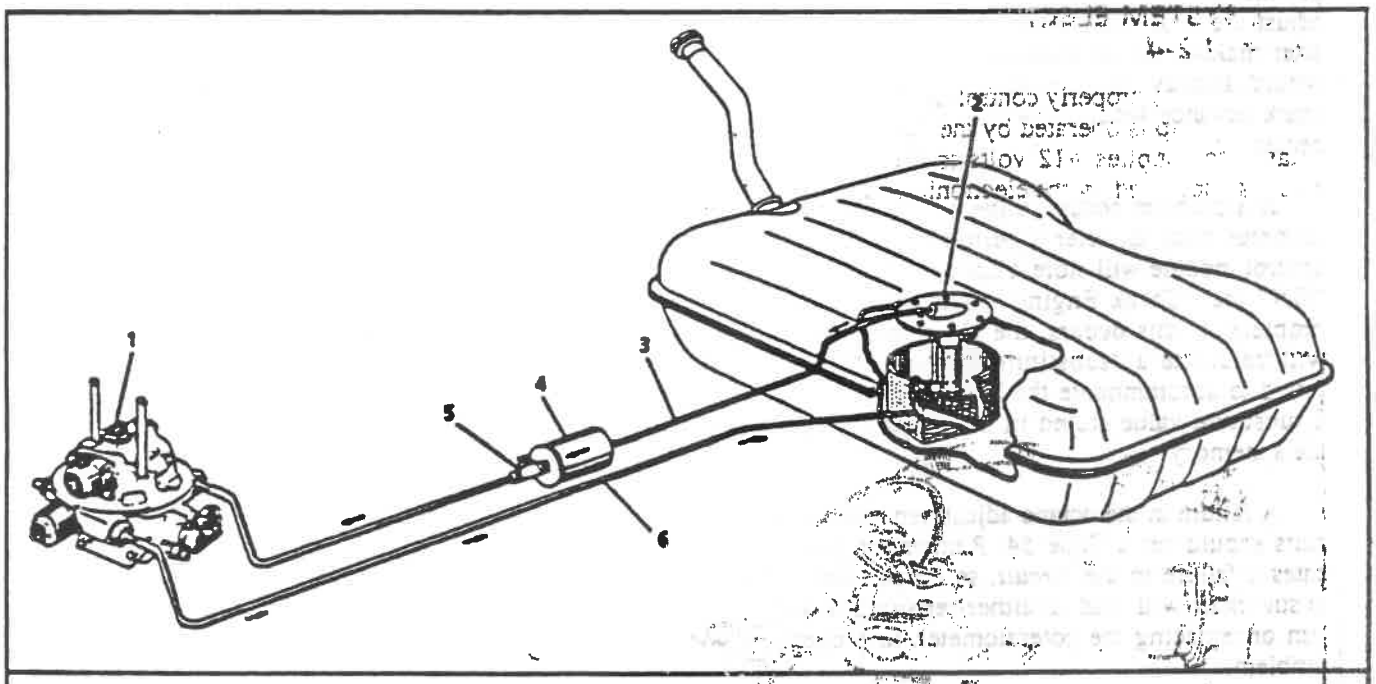
The fuel control system (Figure 1.2-1) starts with the fuel in the fuel tank. An electric fuel pump located inside the fuel tank pumps fuel through the in-line fuel filter and fuel supply line to the throttle body injection unit. The pump is designed to provide pressurized fuel at considerably above 190 kPa (27.6 psi, 1.9 bar). A pressure regulator in the throttle body injection unit keeps fuel available to the injector at a constant pressure between 190 kPa (27.6 psi, 1.9 bar) and 210 kPa (30 psi, 2.1 bar). Fuel in excess of injector needs is returned to the fuel tank by a separate return line.

The injector, located in the throttle body injection unit, is controlled by the electronic control module. It delivers fuel in one of several modes as described later in this section.

COMPONENTS

The fuel control system is made up of the following parts:

- Fuel system electrical control relay
- Fuel pump
- Fuel filter
- Fuel lines
  - Pressure (supply)
  - Return
- Fuel pressure test fitting
- Throttle body injection unit
  - Fuel injector
  - Fuel pressure regulator
  - Idle air control valve
  - Throttle position sensor



1 THROTTLE BODY INJECTOR UNIT
2 FUEL PUMP
3 FUEL SUPPLY PRESSURE LINE
4 FUEL FILTER
5 FUEL PRESSURE TEST FITTING (PART OF SPECIAL TOOL J 38970-V)
6 FUEL RETURN LINE

Figure 1.2-1 - Throttle Body Injection Fuel Supply System

FUEL PUMP
Figure 1.2-2

The fuel pump is an electric roller vane type pump. Fuel is pumped at a positive pressure of more than 190 kPa (27.6 psi, 1.9 bar) from the fuel pump through the in-line fuel filter to the throttle body injection unit. Excess fuel above the regulated pressure is routed through the pressure regulator in the throttle body injection assembly, to the fuel tank through the fuel return line.

Vapor lock problems are reduced when using an electric in-tank fuel pump because the fuel is under pressure rather than under a vacuum, as is the case with an engine mounted mechanical fuel pump.

FUEL FILTER
Figure 1.2-3

The fuel filter is mounted in the engine compartment under the spare tire. The filter is located in the fuel pressure (supply) line, between the fuel pump and the throttle body injection assembly. The filter housing is constructed of steel, with threaded fittings on both ends. The filter element is made of paper, and is designed to trap particles in the fuel that may damage the injection system.

FUEL SYSTEM ELECTRICAL CIRCUITS
Figure 1.2-4

In order to properly control the fuel supply, the electric fuel pump is operated by the fuel system relay. This relay also supplies +12 volts to the fuel injector. The relay is controlled by the electronic control module.

When the ignition switch is turned to "ON" or "CRANK" *after having been "OFF" for at least 15 seconds*, the electronic control module will immediately energize the fuel system relay to operate the fuel pump. This builds up the fuel pressure quickly. If the engine is not cranked within two seconds, the electronic control module will shut the relay "OFF" and wait until the engine is cranked. As soon as the engine begins cranking, the electronic control module will sense the engine turning from the crankshaft position reference signal, and turn the relay "ON" again to run the fuel pump.

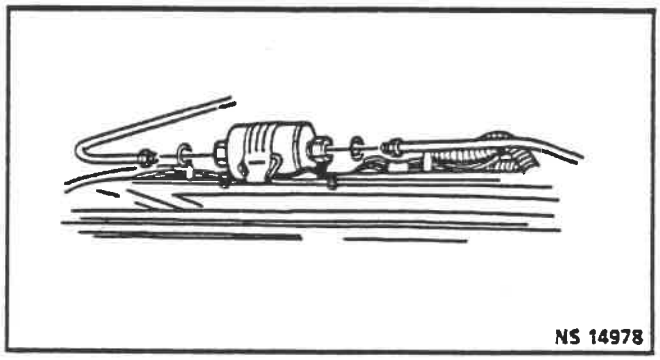


Figure 1.2-3 Fuel Filter

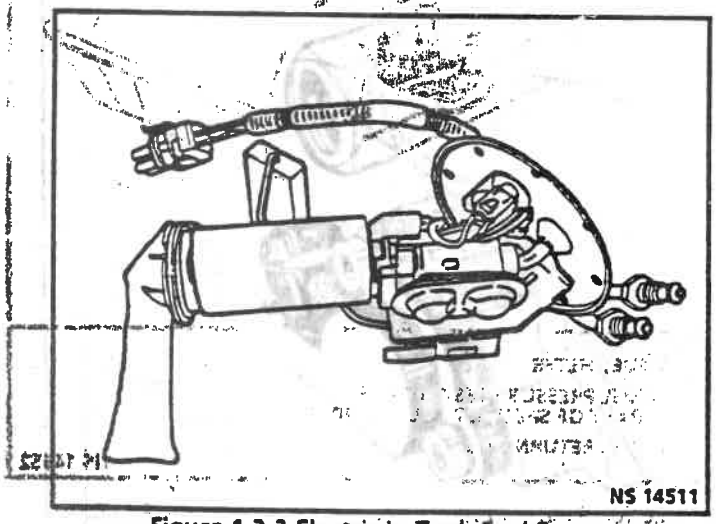


Figure 1.2-2 Electric In-Tank Fuel Pump

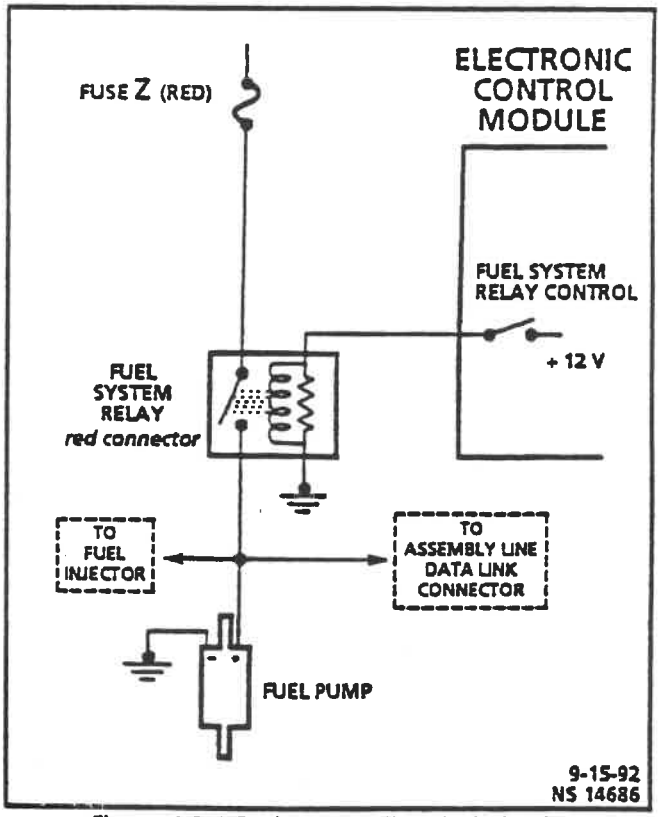


Figure 1.2-4 Fuel System Electrical Circuits

THROTTLE BODY INJECTION UNIT
Figure 1.2-5

Fuel is delivered into the engine by a throttle body injection unit. The throttle body injection unit, Model 700, is located centrally on the intake manifold, and consists of two major assemblies:

1. A Throttle Body, with a throttle valve connected to the accelerator pedal linkage, to control air flow.

2. A Fuel Meter Assembly, with an integral fuel pressure regulator and an electrically actuated fuel injector, to supply the required fuel.

Other important assemblies located on a throttle body injection unit include a throttle position sensor, and a device for idle control, the idle air control valve. The throttle body portion also contains ports located in the throttle bore (above and below the throttle valve), which are used to generate the vacuum signals required for operation of the manifold absolute pressure sensor and the evaporative emissions storage canister.

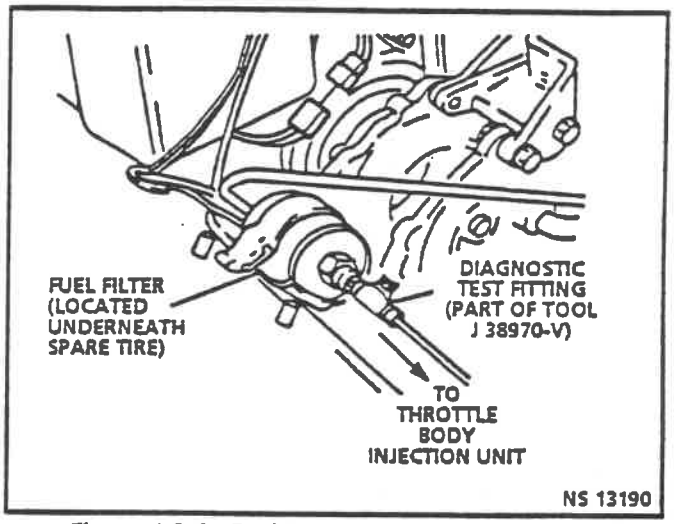

FUEL FILTER (LOCATED UNDERNEATH SPARE TIRE)
DIAGNOSTIC TEST FITTING (PART OF TOOL J 38970-V)
TO THROTTLE BODY INJECTION UNIT
NS 13190

Figure 1.2-6 - Fuel Pressure Diagnostic Fitting

Fuel Pressure Diagnostic Fitting
Figure 1.2-6

Some diagnostic service procedures require that a fuel pressure test be performed. Special tool J 38970-V includes a diagnostic test fitting. During testing, this fitting is temporarily installed in the fuel pressure supply line at the outlet fitting of the fuel filter. This fitting provides a convenient location to connect a fuel pressure gauge, to determine the fuel pressure being delivered to the fuel injector.

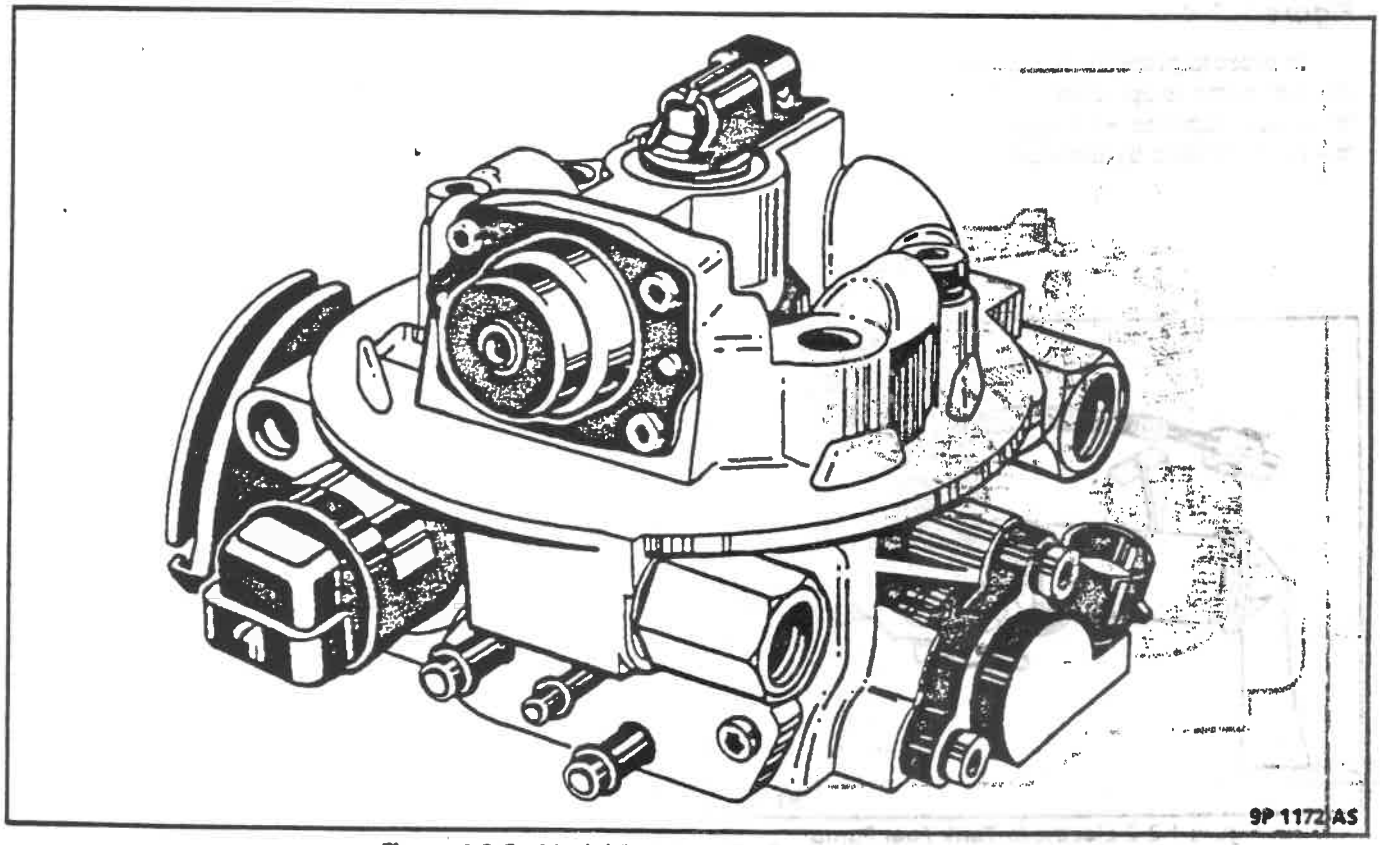


Figure 1.2-5 - Model 700 Throttle Body Injection Unit

Fuel Injector
Figure 1.2-7

A fuel injector is an electromagnetic device containing a solenoid which upon receiving an electrical pulse from the electronic control module pulls the plunger or core piece upward allowing the spring-loaded ball valve to come off the valve seat permitting fuel to flow through a fine screen filter to the atomizer or spray nozzle. The fuel, under pressure, is directed in a conical spray pattern at the walls of the throttle body bore above the throttle valve. When the electrical pulse is complete, the electromagnet is deenergized, and the spring-loaded ball valve closes, shutting "OFF" the fuel spray.

The injector when turned "ON" (energized) by the electronic control module has full system voltage applied to the solenoid coil until the current rises to a reference level of 4 amperes. Current regulation by the electronic control module then takes over maintaining a hold current of 1 ampere until the injector is turned "OFF." This allows a fast pull-in of the solenoid during turn-"ON" and a low energy holding state which prevents the solenoid coil from overheating. This current limiting feature is used due to the low resistance of the throttle body injection 700 fuel injector solenoid coil. Nominal resistance is 1.52 ohms ± 0.1 at 22°C.

Fuel Pressure Regulator
Figure 1.2-7

Fuel is supplied to the throttle body injection unit from a constant flow fuel pump. A filter in the fuel supply line protects the precision components within the throttle body injection unit from damage by fuel borne solids.

A diaphragm controlled flow valve within the fuel meter assembly maintains fuel pressure within specified limits. Regulation is achieved by balancing fuel pump pressure against the preset tension of the pressure regulator spring.

Should fuel pressure drop below the design limit, the pressure regulator spring forces the diaphragm and valve against the valve seat. With the regulator valve closed, fuel returning back to the fuel tank is stopped, and inlet pressure is allowed to increase. Fuel pressure above the design limit overcomes the pressure regulator spring tension, pushing open the valve to bleed excess pressure into the fuel return line.

Fuel flow calibration is based on holding the system's fuel pressure within specified limits. To accomplish this, the fuel pump must produce sufficient pressure to overcome the pressure regulator preset tension.

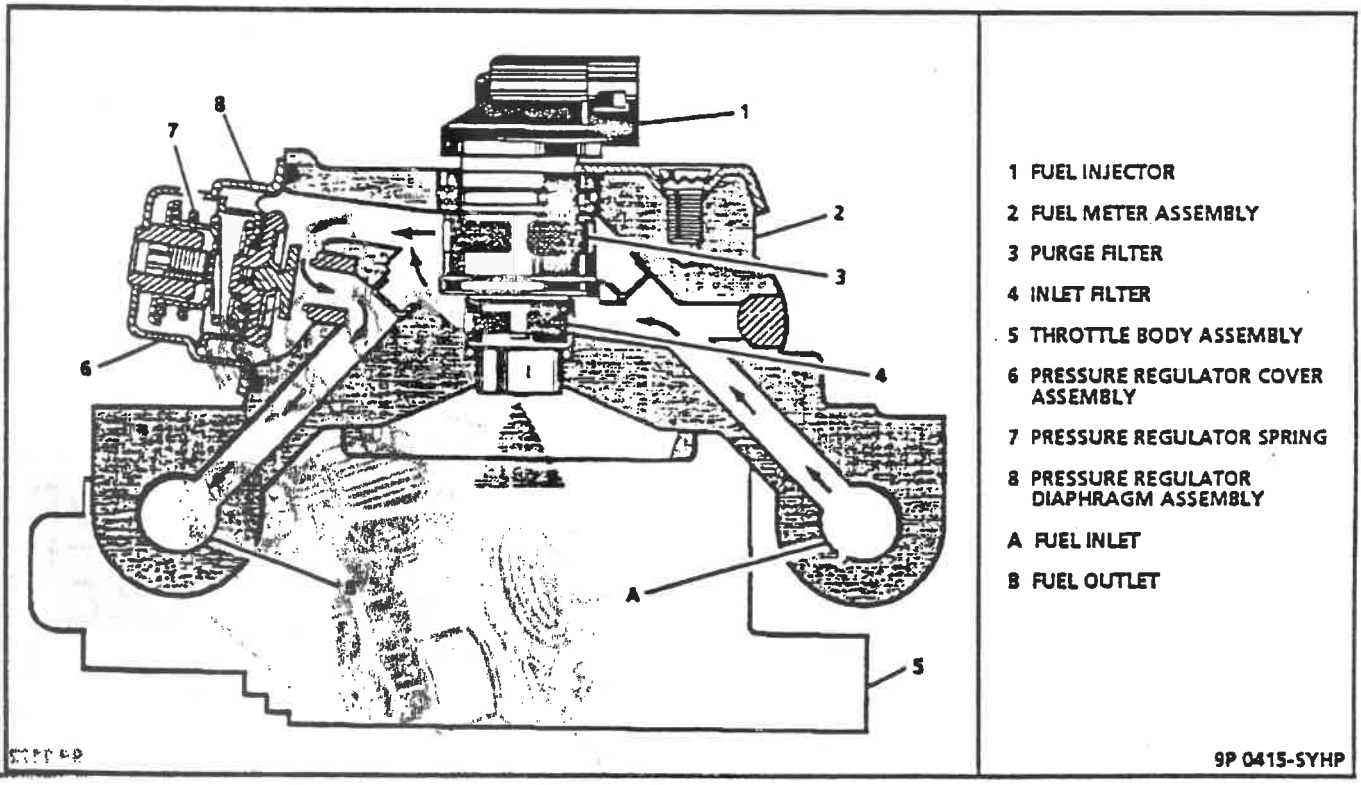


Figure 1.2-7 Fuel Injector and Pressure Regulator, Shown in the Fuel Meter Assembly

Fuel Metering
Figure 1.2-7

Accurate fuel metering in the Model 700 throttle body injection unit results from the precise regulation of fuel pressure and injector timing. An injector control signal consisting of a series of "ON" and "OFF" pulses originates from the electronic control module in response to engine fuel needs. This series of pulses is usually synchronized with engine speed signal (crankshaft reference) pulses that are sent to the electronic control module from the ignition system. The injector control signal when applied to the injector, energizes the injector's solenoid. The solenoid opens a normally closed ball valve releasing a conical spray of pressurized fuel into the throttle bore just above the throttle valve.

Since fuel pressure is held constant by the regulator, the volume of fuel flow is proportional to the length of time that the injector is held open (pulse width) and the frequency (repetition rate) of the applied pulses. By varying the pulse width, the electronic control module maintains the optimum air/fuel ratio. Increasing the pulse width results in a greater fuel flow (enriched air/fuel ratio). A reduction in pulse width decreases the fuel flow resulting in a leaner air/fuel ratio. The repetition rate is generally determined by engine speed. The electronic control module initiates injector pulses by monitoring engine speed from a crankshaft position reference signal to the electronic control module from the ignition system.

The electronic control module modifies pulse width to meet the changes in engine fuel demand (such as cold starts, altitude, acceleration, deceleration, et cetera).

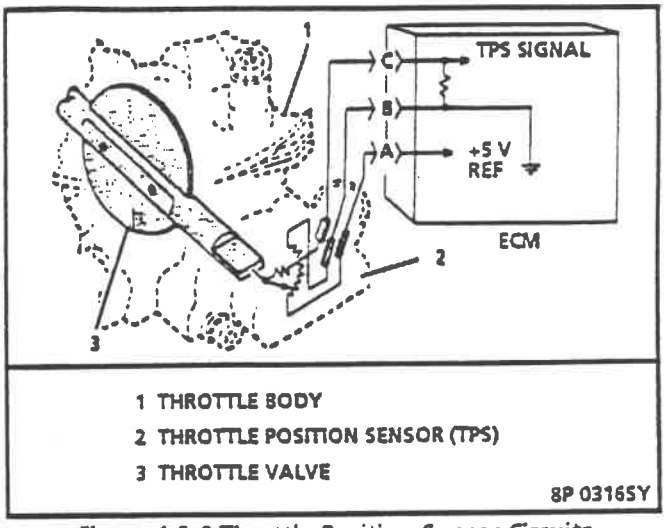
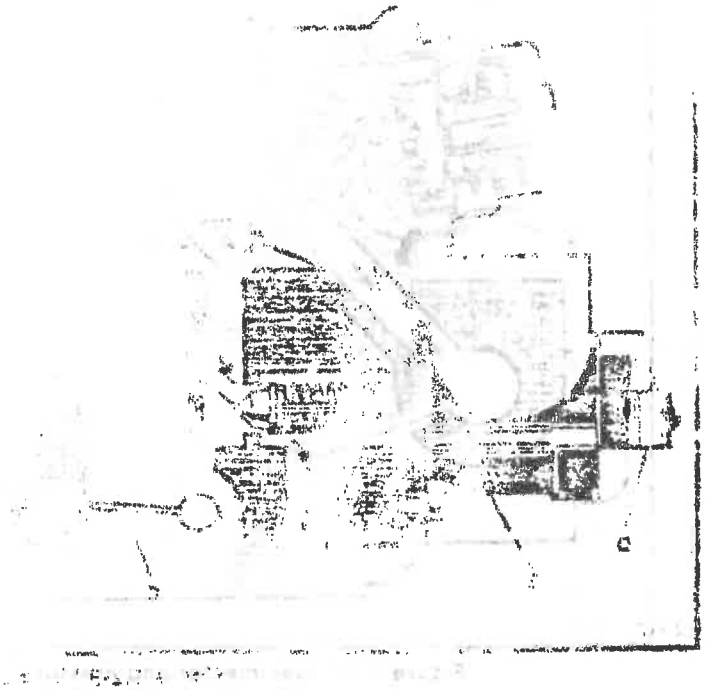


Figure 1.2-8 Throttle Position Sensor Circuits

Throttle Position Sensor
Figure 1.2-8

The throttle position sensor is a part of the throttle body injection unit. It is mounted on the side of the throttle body opposite the throttle lever assembly. As the throttle valve rotates in response to movement of the accelerator pedal, the throttle shaft transfers this rotational movement to the throttle position sensor. When this occurs, the throttle position sensor output signal voltage changes. More information about the throttle position sensor is available in Section 1.1 "Electronic Control Module and Sensors," of this manual.



IDLE AIR CONTROL VALVE
Figure 1.2-9

The idle air control valve assembly consists of a two-coil, bi-polar stepper motor connected to a tapered pintle valve. Seated in the idle air bypass channel of the throttle body injection unit (Figure 1.2-9), the idle air control valve pintle extends or retracts in response to control signals supplied by the electronic control module. The idle air control valve adjusts idle speed by controlling the amount of bypass air around the closed throttle valve.

When fully extended (seated = zero (0) steps), the pintle valve blocks the flow of bypass air around the throttle valve. Retracting the pintle allows bypass air to flow in proportion to the number of steps the pintle moves away from its seat (fully retracted = 255 steps).

Since the electronic control module can command the idle air control valve to move any number of steps (0–255 from fully extended to fully retracted), the volume of idle bypass air (and ultimately, engine revolutions per minute) is adjusted to meet closed throttle engine loading.

Closed throttle desired engine speed (in revolutions per minute) is programmed into the electronic control module for normal engine conditions. The idle air control valve, under control of the electronic control module, allows an increase or decrease in idle speed as engine conditions warrant.

Besides controlling idle speed, the idle air control valve helps to reduce emissions. When the throttle is closed during vehicle deceleration from road speed, the idle air control valve allows an increased bypass air flow to go around the closed throttle valve, producing a leaner air/fuel mixture. This reduces hydrocarbon and carbon monoxide emissions that occur during rapid throttle closing.

There is no direct signal to the electronic control module as to the actual position of the idle air control valve. The electronic control module "resets" the idle air control valve each time the ignition is turned "OFF." This is accomplished by causing the idle air control valve to fully extend to a seated, shut position (0 steps) after the engine stops. At this position, the control module "knows" the valve is at a "zero" position. The control module then retracts the valve a calculated number of steps, to allow sufficient air for subsequent engine starts.

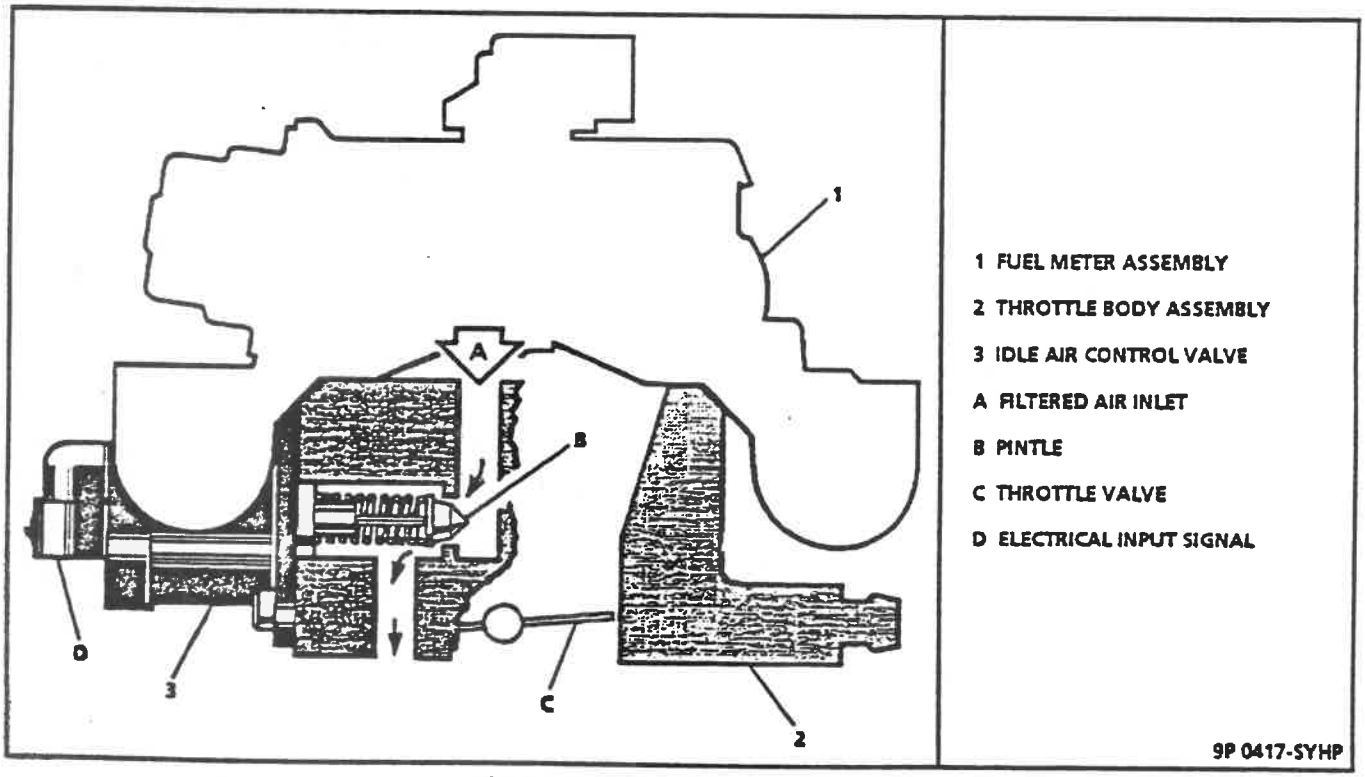


Figure 1.2-9 Idle Air Control System

SPEED-DENSITY FUEL CONTROL

The NIVA 1.7L throttle body injection engine management system uses what is called a "speed-density" method of calculating the correct fuel requirements, for any engine operating condition. An air/fuel mixture can be expressed as an air/fuel ratio.

In order to deliver the correct amount of fuel, the airflow going into the engine must be known. These two factors: engine speed, and air density in the intake manifold, are used together to calculate the total airflow into the engine, so that the correct amount of fuel may be delivered to maintain the desired air/fuel mixture.

This method of airflow calculation begins in an engine dynamometer laboratory. First, an actual 1.7L NIVA engine, fully equipped with the complete throttle body fuel injection system, is fitted onto a dynamometer. Then, the engine is run at all possible combinations of engine speed and load.

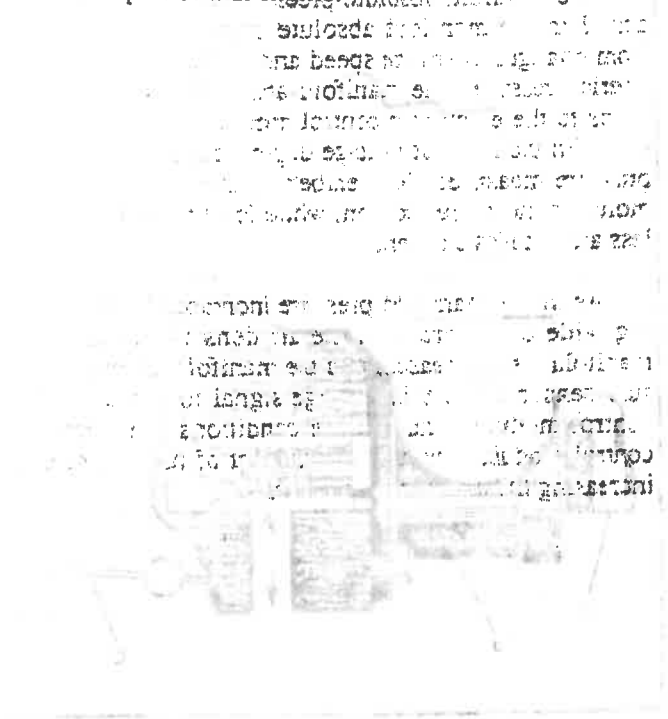
While this test is being performed in the laboratory, information is being entered into a laboratory computer's memory about actual engine speed, intake manifold absolute pressure, and intake air temperature. (These last two, intake manifold absolute pressure and air temperature, combine to form the "air density" factor, explained later.)

With these three pieces of information, several "lookup tables" of information are developed in the memory of the laboratory computer. One of these is called a "volumetric efficiency" lookup table, and is a comparison of the theoretical airflow through the engine based on cylinder displacement and engine speed, as compared to the calculated airflow based on intake manifold absolute pressure, intake air temperature and engine speed. Various factors of the basic engine design affect volumetric efficiency, such as camshaft lift, duration, and overlap, intake and exhaust valve size, air induction and exhaust system design, combustion chamber design, exhaust backpressure, et cetera.

Knowing what the volumetric efficiency is at any engine speed, plus knowing the air density of the available air in the intake manifold, it is possible to calculate the airflow into the engine.

These "lookup tables" of information are permanently programmed into the on-car electronic control module's memory. Equipped with the lookup tables of engine volumetric efficiency at any engine speed, plus on-vehicle measurements of intake manifold absolute pressure, intake air temperature, and actual engine speed, the vehicle's electronic control module can *calculate* engine airflow.

Now, on any vehicle equipped with exactly the same type engine as was measured and documented in the dynamometer laboratory, the airflow of a particular vehicle's engine can be calculated by using the lookup table of information, along with inputs from the sensors that are a part of that engine.



SPEED-DENSITY CALCULATION

As described previously, to calculate the airflow going into the vehicle's engine, the electronic control module uses two factors—engine speed and air density. Engine speed is obtained directly from a signal coming from the ignition module. The second factor, air density, is calculated from two other sensor input signals.

Speed

The engine speed signal comes from the ignition system, and goes to the electronic control module on its crankshaft reference input signal circuit. The electronic control module uses this information to determine the "engine speed" factor for fuel and ignition management. This engine speed signal is *the single most important input signal* to the electronic control module. Without it, the electronic control module cannot calculate any fuel injector pulses, and the engine can not run.

Density

The density of the air, or how tightly packed are the molecules of oxygen in the intake manifold, is an indicator of how much oxygen is available to be used for combustion inside the engine. Air density can change according to atmospheric pressure, air temperature, and throttling of the incoming air on a running engine. Denser air means more molecules of oxygen, and more fuel would be required to maintain the correct air/fuel ratio. Also, less dense air requires less fuel for a proper air/fuel ratio.

The manifold absolute pressure sensor monitors the actual intake manifold absolute pressure which results from changes in engine speed and throttling, and atmospheric pressure. The manifold absolute pressure sensor sends to the electronic control module an electrical signal, with the level of voltage depending on the manifold pressure measured. Remember, higher pressure means more air and more oxygen, while lower pressure means less air and less oxygen.

As intake manifold pressure increases (such as during wide open throttle), the air density in the intake manifold also increases, and the manifold absolute pressure sensor sends this voltage signal to the electronic control module. Under these conditions the electronic control module increases the amount of fuel injected by increasing the injector pulse width.

Conversely, as manifold pressure decreases, the amount of required fuel also decreases. The manifold absolute pressure sensor's output voltage is reduced, and the injector pulse width is decreased by the electronic control module.

To complete the air density factor, the temperature of the incoming air must be known. Just as the pressure of the air in the intake manifold is an indicator of how much oxygen is available for combustion, air temperature is also an indicator. Lower air temperature is "denser," meaning it has more oxygen, while hotter air has less oxygen.

Located into the underneath side of air cleaner, the intake air temperature sensor constantly measures the temperature of the air entering the intake manifold and converts the temperature into an electrical signal sent to the electronic control module.

These three input signals: engine speed, manifold absolute pressure, and intake air temperature, are the major determinants of the "engine running" air/fuel mixture delivered by the fuel injection system. The remaining sensors provide electrical inputs to the electronic control module which are used for minor modification of the air/fuel mixture, as well as for other electronic control module control functions.

Note about air density's effect on maximum available engine power.

For those of you who have experienced driving a vehicle at high altitude, knowing about this air density factor should help explain why the engine seems to be less powerful at high altitudes than when operated at sea level. There is less available oxygen in the less dense air found at higher altitudes! The same holds true for a hot day compared to a cool day. Needless to say, most record holders of vehicle speed records have recorded their highest speeds while operating their engines at lower altitudes on cool days, when the density of the air (and available oxygen for combustion) is at its highest possible level.

MODES OF FUEL CONTROL OPERATION

As discussed previously in this section, the amount of fuel delivered by the injector is controlled by an electrical signal from the electronic control module. Injection pulses normally occur once for each crankshaft position reference pulse sent from the ignition system to the electronic control module. For a four cylinder engine, these crankshaft reference pulses (and synchronous injector pulses) occur twice per crankshaft revolution (Figure 1.2-10).

The electronic control module monitors a number of engine operating conditions, calculates the fuel requirements, and determines the proper fuel injector delivery time. **This delivery time is called "injector pulse width,"** and can be observed using the Tech 1 diagnostic tool. To increase the amount of fuel delivered, the pulse width is lengthened. To reduce the amount of fuel delivered, the pulse width is shortened. Pulse width is modified by the electronic control module for various operating conditions such as cranking, high altitude, power enrichment, or deceleration.

The electronic control module monitors several sensors to determine how much fuel the engine needs. The fuel is delivered in one of two different methods; either *synchronous:* in time with, or initiated from crankshaft reference input signal pulses (Figure 1.2-10), or *asynchronous;* independent of, or not timed with crankshaft position reference pulses (Figure 1.2-11).

Synchronous fuel delivery (that is, synchronized with or in time with crankshaft reference pulses) is the most used method of fuel delivery. Asynchronous fuel delivery is primarily used when extra fuel is required due to rapid throttle opening, as seen by the throttle position sensor. Asynchronous fuel pulses are similar to the extra fuel delivered by a carburetor accelerator pump, when the throttle is opened quickly.

Regardless of the delivery method, fuel is controlled under one of several conditions, called "modes." All of the modes are electronic control module controlled, and are described in the next few paragraphs.

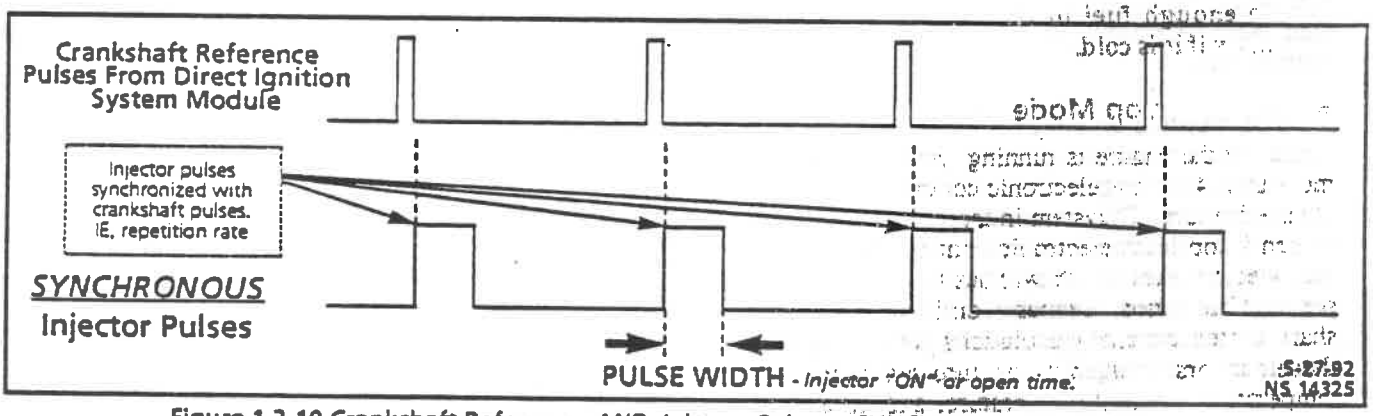

Crankshaft Reference Pulses From Direct Ignition System Module
Injector pulses synchronized with crankshaft pulses. IE, repetition rate
SYNCHRONOUS Injector Pulses
PULSE WIDTH - Injector "ON" or open time.
5-27-92 NS 14325

Figure 1.2-10 Crankshaft Reference *-AND-* Injector Pulses – *SYNCHRONOUS* Fuel Delivery

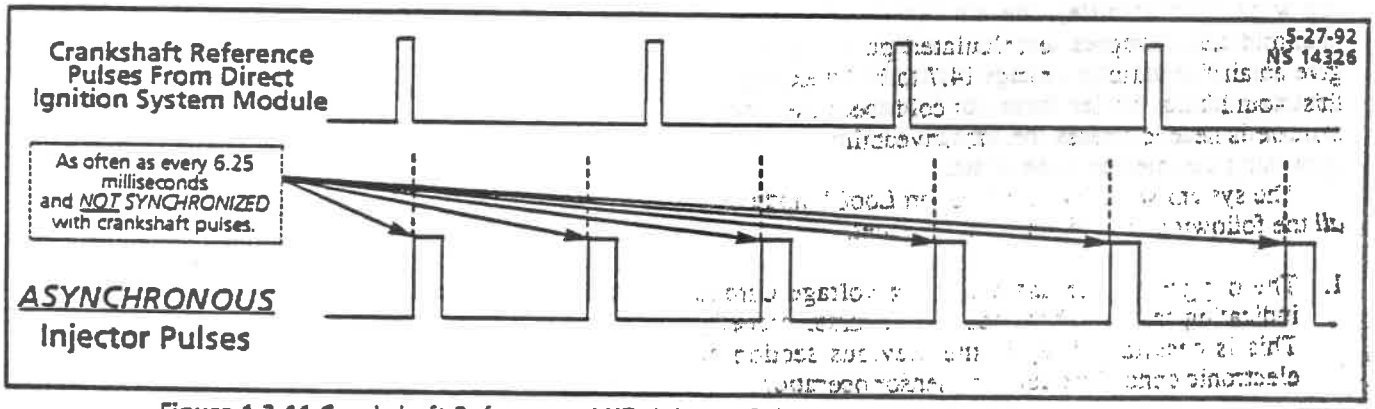

Crankshaft Reference Pulses From Direct Ignition System Module
As often as every 6.25 milliseconds and NOT SYNCHRONIZED with crankshaft pulses.
ASYNCHRONOUS Injector Pulses
5-27-92 NS 14326

Figure 1.2-11 Crankshaft Reference *-AND-* Injector Pulses – *ASYNCHRONOUS* Fuel Delivery

Starting Mode

When the ignition is first turned "ON," the electronic control module will turn "ON" the fuel system relay for two seconds, and the fuel pump will build up pressure to the throttle body injection unit. The electronic control module checks the coolant temperature sensor to determine the proper air/fuel ratio for starting.

When cranking begins, the electronic control module will operate in the "Starting" mode until engine revolutions per minute are more than 420, *-or-* the "Clear Flood" mode is enabled.

Clear Flood Mode

If the engine floods (that is, spark plugs wetted with liquid fuel), it can be started by opening the throttle fully while cranking the engine. The electronic control module then pulses the injector with only a 26:1 air/fuel ratio (about a 2 millisecond pulse width), which should "clear" a flooded engine. The electronic control module holds this pulse width as long as the throttle position sensor input indicates the throttle is nearly wide open (more than 85%), and revolutions per minute are below 420.

If the throttle is held wide-open while attempting to make a normal start with a non-flooded engine, the engine may not start. A 26:1 air/fuel mixture may not be enough fuel to start a non-flooded engine, especially if it is cold.

Run Open Loop Mode

After the engine is running (revolutions per minute more than 420), the electronic control module will operate the fuel control system in the "Open Loop" mode. In "Open Loop," the electronic control module calculates the injector pulse width without the use of the oxygen sensor. Calculations are based on inputs from the crankshaft reference signal (revolutions per minute input) and these sensors: manifold absolute pressure, intake air temperature, coolant temperature, and throttle position sensor.

In "Open Loop," the calculated pulse width may give an air/fuel ratio other than 14.7 to 1. An example of this would be when the engine is cold, because a richer mixture is needed to ensure good driveability.

The system will stay in the "Open Loop" mode until *all* the following conditions have been met:

1. The oxygen sensor has a varying voltage output, indicating that it is hot enough to operate properly. This is described fully in the previous section on electronic control module and sensor operation.
2. The engine coolant temperature is more than 32°C.
3. The engine has been running more than a period of time, since the engine was started. The time can vary between 6 seconds up to 5 minutes, based on the coolant temperature when the engine was started. At the extremes, if engine coolant temperature was less than 18°C at startup, then 5 minute would apply. If the coolant temperature was more than 75°C at startup, the 6 second delay would apply.

Run "Closed Loop" Mode

In "Closed Loop" mode, the electronic control module initially calculates injector pulse width based on the same sensors used in "Open Loop." The difference is that in "Closed Loop," the electronic control module uses the exhaust gas oxygen sensor signal to modify and precisely fine tune the fuel pulse width calculations in order to precisely maintain the 14.6 to 14.7: 1 air/fuel ratio that allows the catalytic converter to operate at its maximum conversion efficiency.

Acceleration Enrichment Mode

The electronic control module looks at rapid increases in throttle position and manifold pressure, and provides extra fuel by increasing the injector pulse width. If the increased fuel requirements are great enough due to rapid throttle opening, the electronic control module may add extra asynchronous fuel injection pulses between the synchronous injector pulses that normally occur once per crankshaft position reference pulse.

The acceleration enrichment mode is for transitional (when the throttle is moving) fueling needs only.

Power Enrichment Mode

The electronic control module monitors the throttle position sensor and engine speed to determine when maximum engine power is being requested by the driver. Maximum engine power output requires a richer mixture (more fuel) than 14.7 to 1. When the power enrichment mode is active, the electronic control module changes the air/fuel ratio to approximately 12 : 1. When this mode is active, the oxygen sensor signal is ignored, since its signal would be indicating a rich exhaust. The status of this mode can be observed using the Tech 1 diagnostic tool.

Deceleration Enleanment Mode

When closed throttle engine deceleration occurs, the fuel remaining in the intake manifold can cause excessive emissions. The electronic control module monitors for a reduction in both throttle position and manifold pressure, and reduces the fuel by decreasing the pulse width.

Decel Fuel Cut Mode

When closed throttle deceleration from high road speed occurs with the transmission in gear and the clutch engaged, the electronic control module has the ability to cut off fuel pulses completely for short periods. This is called the Decel Fuel Cut mode. The status of this mode can be observed using the Tech 1 diagnostic tool.

The decel fuel cut mode occurs when *ALL* these conditions are met:

1. Coolant temperature above 44°C.
2. Engine revolutions per minute above 3150.
3. Vehicle speed above 42 km/h.
4. Throttle is closed.
5. Manifold absolute pressure input indicates no engine load (less than 24 kPa).
6. Transmission is determined to be "in gear," by a lookup table comparing engine speed with vehicle speed.

When decel fuel cut is in effect, *ANY* one of these can cause injection pulses to restart.

1. Engine revolutions per minute below 2100.
2. Vehicle speed is less than 42 km/h.
3. Throttle is open at least 2%.
4. Manifold absolute pressure input indicates some engine load (more than 25 kPa).
5. Clutch is determined to be "de-clutched," or disengaged. This can be determined if the engine revolutions per minute is dropping very rapidly.

Battery Voltage Correction Mode

At low battery voltages, the ignition system may deliver a weak spark, and the injector mechanical movement takes longer to "open." The electronic control module will compensate by:

- Increasing ignition coil dwell time if voltage is less than 12 volts.
- Increasing idle engine speed revolutions per minute and injector pulse width, if voltage drops below 8 volts.

Fuel Cutoff Mode

No fuel is delivered by the injector when the ignition is "OFF." This prevents dieseling. Also, fuel pulses are not delivered if the electronic control module receives no crankshaft reference pulses from the ignition module, which means the engine is not running.

The Fuel Cutoff Mode is also enabled at:

- High engine speed, as an overspeed protection for the engine. When fuel cutoff is in effect due to engine speed of more than 6,500 revolutions per minute, injection pulses will resume after engine speed drops below 6,300.

Adaptive Adjustment of Fuel Injector Pulsewidth

Adaptive learning is the ability of the on-board computer to measure the results of its calculations and output commands, and then remember and act upon its most recent operating experience. The electronic control module uses this remembered information to "learn from experience," and to make adjustments according to what it learned.

As an example, with respect to "Closed Loop" fuel control, if the fuel supply system were to develop low fuel pressure, the oxygen sensor input signal to the electronic control module would indicate a lean exhaust condition. The electronic control module will immediately adjust the injector control pulse width richer ("Closed Loop Fuel Adjustment") to correct for this exhaust condition, and after a length of time will transfer this *adjustment value* into memory ("Memory Fuel Adjustment"). The electronic control module will use this adjustment in its injector pulsewidth calculations until the fuel pressure problem is repaired.

After repairs have been performed, the electronic control module will eventually relearn to the original preprogrammed injector pulse width. The Closed Loop fuel adjustment, using the oxygen sensor signal, updates or "relearns" the memory fuel adjustment value, when the fuel control system is operating in the "Closed Loop" mode.

Memory fuel adjustment is used during both "Open" and "Closed Loop" fuel control. However, the memory fuel adjustment value is updated, or "relearned" only in "Closed Loop."

Adaptive learning is an on-going process that continues throughout the life of the vehicle.

Closed Loop Fuel Adjustment

Closed Loop fuel adjustment represents adjustments to the fuel injector pulse width calculations, based on the oxygen sensor input signal to the electronic control module, when the fuel control system is operating in the "Closed Loop" mode.

When the engine is first started, the electronic control module will control the fuel injection pulse width in the "Open Loop" mode, based upon various sensor inputs such as manifold absolu... pressure, engine speed, coolant temperature, and throttle position. During this "Open Loop" period, "closed loop fuel adjustment" is disabled and will read 0% on the Tech 1 "Scan" tool.

When the oxygen sensor has come up to its normal operating temperature it will produce a varying voltage to the electronic control module and provide a good indication of what has happened in the combustion chambers. At this time the electronic control module will change from "Open Loop" to "Closed Loop" fuel control, and the Closed Loop fuel adjustment will start to constantly monitor the oxygen sensor signal, so that the electronic control module can calculate and/or modify the fuel injector pulse width with greater accuracy than in "Open Loop."

The "no correction needed" value for Closed Loop fuel adjustment is 0%. Any change from 0% indicates the Closed Loop fuel adjustment is modifying the fuel injector pulse width. If the Closed Loop fuel adjustment value is above 0%, the fuel injector pulse width is being increased, thus adding more fuel. If the Closed Loop fuel adjustment value is below 0%, the fuel injector pulse width is being decreased, thus removing fuel. The normal operating range of Closed Loop fuel adjustment is considered to be between –20% and +20%; any value out of this range is usually caused by a malfunction.

If the exhaust is lean, additional "Closed Loop fuel adjustment" fuel pulsewidth will be added until the oxygen sensor signal voltage indicates the exhaust is rich. The opposite is also true: if the exhaust is too rich, the "Closed Loop fuel adjustment" will reduce the injector pulsewidth until it detects a lean exhaust. If the Closed Loop fuel adjustment continues to see a low or high oxygen sensor signal voltage (lean or rich exhaust), it will continue to try and compensate for the exhaust condition until it reaches its limits of control.

The calibrated limits of Closed Loop Fuel Adjustment are set to allow (from the original calculation) no more than +63% of additional pulsewidth, or to reduce pulsewidth by a maximum reduction of –54%.

These changes in Closed Loop fuel adjustment occur only during "Closed Loop" fuel control, and are used to update the "Memory Fuel Adjustment."

Memory Fuel Adjustment

"Memory fuel adjustment" is a portion of the electronic control module memory used to adjust fuel delivery across all operating conditions of the engine, even during open loop fuel control. "Memory fuel adjustment" monitors the "closed loop fuel adjustment," and will modify a "learned" memory value of fuel injector pulse width correction, if the Closed Loop fuel adjustment has been high or low for a certain period of time. Memory fuel adjustment is relearned or updated only when the fuel control system is operating in "Closed Loop" mode. A "no correction needed" memory value is 0%, with normal ranges of adjustment being between –10% and + 10%.

The calibrated limits of Memory Fuel Adjustment are set to allow (from the original calculation) no more than +50% of additional pulsewidth, or to reduce pulsewidth by a maximum reduction of –38%.

Memory fuel adjustment provides the electronic control module with the ability to make semipermanent changes to its injector pulsewidth calculations, to compensate for normal changes or "build tolerances" in the operating characteristics of all the fuel handling components.

As an example of how the "closed loop fuel adjustment" and "memory fuel adjustment" can compensate for some causes of a too-rich or too-lean exhaust, follow this next example:

If the fuel pressure were to suddenly increase above acceptable limits for any reason, the exhaust gases would quickly change to a rich condition. This happens because with fuel pressure that is too high, the actual delivered fuel from the injector would increase, even though the pulsewidth stayed the same.

If the fuel control system were operating in the "Closed Loop" mode, the "closed loop fuel adjustment" value would immediately decrease to less than 0%, maybe (for example) to –15%, to decrease the injector pulsewidth. If this Closed Loop fuel adjustment value change did not compensate for the subsequent too-rich exhaust, the electronic control module will continue to decrease the Closed Loop fuel adjustment value. The "Closed Loop fuel adjustment" value may decrease as low as its calibrated minimum allowable limit (–54%) if there is a continued rich exhaust indication. (This example could be a real situation, if for any reason the "return fuel" line, needed to return excess fuel pressure back to the fuel tank, were to become pinched shut.)

The "memory fuel adjustment" will monitor the "closed loop fuel adjustment" value as it decreases, but it will not make any changes of its own to the fuel injector pulse width for a period of time. After a period of time has elapsed and the Closed Loop fuel adjustment value has remained low, the memory fuel adjustment will decrease a small amount to (example) –5%, and wait to see if the Closed Loop fuel adjustment has come back up to 0%.

If after this memory fuel adjustment is made, the Closed Loop fuel adjustment continues to be less than 0%, the "memory fuel adjustment" will continue to move down toward its calibrated minimum limit (–38%), attempting to optimize the air/fuel mixture of the fuel injection control system.

When the "Memory Fuel Adjustment" value has sufficiently increased or decreased the injector pulsewidth, meaning that the oxygen sensor indicates the exhaust is now neither too rich or lean, the "Closed Loop Fuel Adjustment" will return to approximately 0%, making no further pulsewidth correction. In our previous example of abnormally high fuel pressure, the hopeful end result is that the "Memory Fuel Adjustment" value might go down to –25%, and the "Closed Loop Fuel Adjustment" would return to 0%.

If both "Memory Fuel Adjustment" and "Closed Loop Fuel Adjustment" have moved to each of their adjustment limits, after a short period of time the fuel control system will be determined to be "out of control." When this occurs, the electronic control module will turn "ON" the Check Engine light and store in its memory either a Diagnostic Trouble Code 44 (lean exhaust) or 45 (rich exhaust), and change back into "open loop" fuel control.

If either the Acceleration Enrichment, Power Enrichment, or Decel Fuel Cut modes are in effect, the electronic control module sets the "Closed Loop fuel adjustment" to 0% and holds it there until these fuel control modes are no longer in effect. This is done so that the memory fuel adjustment will not try to correct for the commanded richness or leanness of any of these three normal modes of fuel control.

Memory Fuel Adjustment Cell
Figure 1.2-12

The memory fuel adjustment function of the electronic control module is divided up into two different sets of 16 cells, arranged by boundaries of engine load (manifold absolute pressure) and engine speed (revolutions per minute). The two different sets of cells represent two different lookup tables. The choice between the two tables is selected by whether or not the evaporative emissions storage canister solenoid is being commanded "ON" or "OFF." There are two additional "idle" cells, each with selections dependent on air conditioning operation and evaporative emissions purge operation.

Each cell corresponds to a region on the engine load versus engine speed table, shown below. Each region is initially calibrated to a memory fuel adjustment value of 0%. A value of 0% in a given cell indicates no fuel adjustment is needed for that engine speed and load condition. A higher number, for example +3%, indicates that the electronic control module has seen a lean exhaust indication under those conditions, and is adding fuel (increasing fuel injector pulse width) to compensate.

Conversely, a lower number, for example –5%, indicates that the electronic control module has seen a rich exhaust indication under those load conditions, and is subtracting fuel (decreasing fuel injector pulse width) to compensate.

The electronic control module will keep the latest memory values stored in its memory fuel adjustment cells. Manifold absolute pressure sensor pressure readings and engine speed are used by the memory to determine what "adjustment cell" to use. Memory fuel adjustment values are stored in the electronic control module's long term memory, for use each time the engine speed and load matches one of the memory cells. All memory fuel adjustment values are reset to 0% when the electronic control module's "long term memory power supply" is disconnected, as when the negative battery cable is disconnected to clear any stored diagnostic trouble codes.

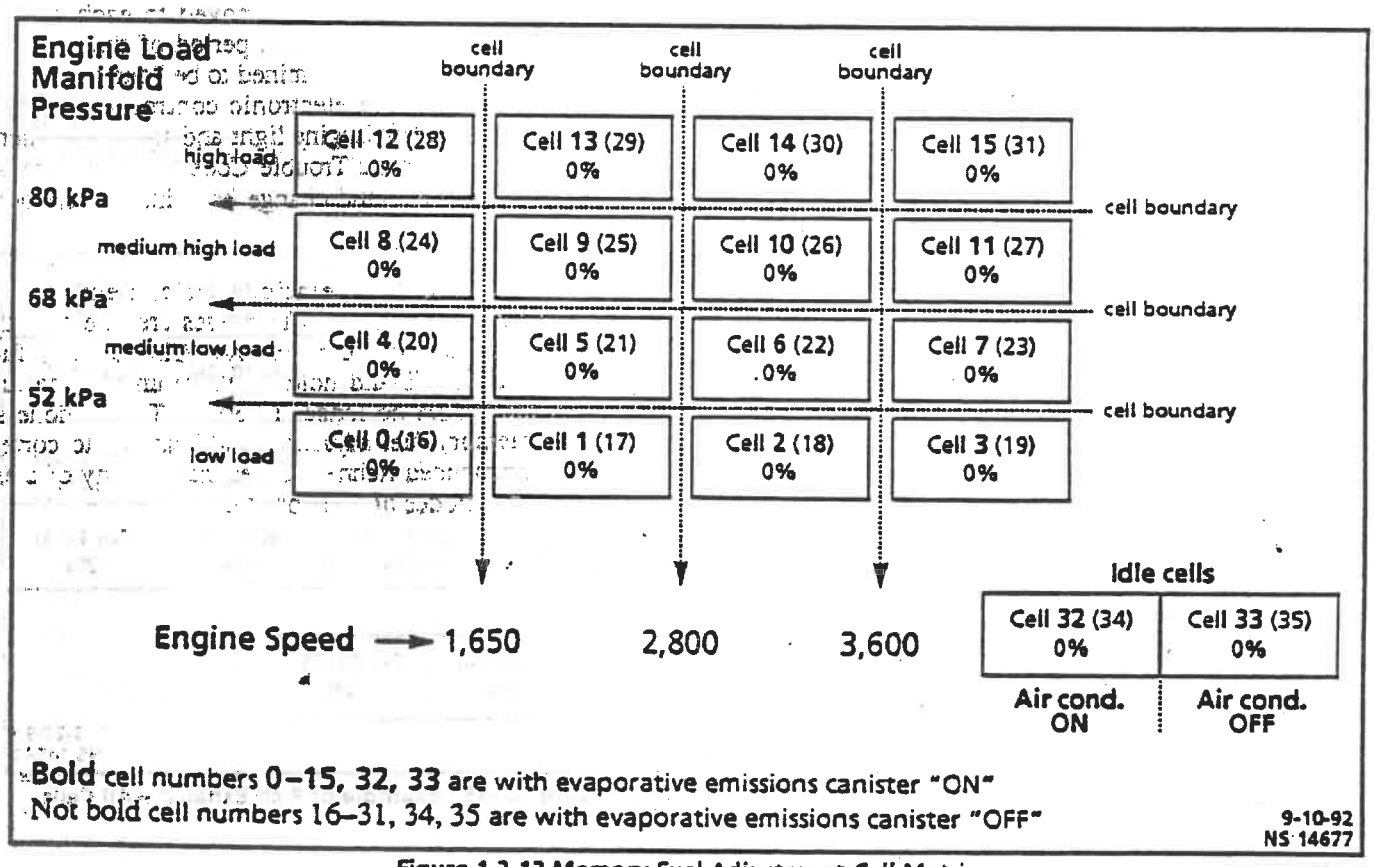


Figure 1.2-12 Memory Fuel Adjustment Cell Matrix

As the vehicle is driven from a standing stop and accelerated or decelerated from various engine speeds, the memory will change from one cell to another cell. When the engine is idling, it will be in cell #32 – 35. If the engine is operating at 3,000 revolutions per minute and the manifold pressure is at 60 kPa, the electronic control module will be using the memory fuel adjustment value from cell #6/22. Whatever cell the engine is operating in, the electronic control module will read that cell's particular memory fuel adjustment value, and adjust the fuel injector pulse width to compensate for a rich or lean condition in the engine (Figure 1.2-13).

As an example, if an engine has low fuel pressure and the customer has driven the vehicle like this for quite some time, the Closed Loop fuel adjustment value would have been high, and the electronic control module would be compensating for this lean exhaust condition by adding more fuel, by increasing the injector pulsewidth. Because the Closed Loop fuel adjustment value is above 0%, memory fuel adjustment will also be greater than 0% in most of the cells to compensate for the lean exhaust.

If you suspect a driveability problem associated with a rich or lean condition, then use the Closed Loop fuel adjustment value to see what the fuel control system is doing *at the present time*. Use the memory fuel adjustment to identify what the system has *"learned" over a greater period of time* to compensate for the condition. Use the memory cells to determine if the fuel control system is rich or lean throughout the operating range (Figure 1.2-14 and 1.2-15). If it is only rich or lean at idle or part throttle, look for components that would cause problems in these areas.

Cell 12 (28) +11%	Cell 13 (29) +16%	Cell 14 (30) +7%	Cell 15 (31) +40%
Cell 8 (24) +16%	Cell 9 (25) +33 %	Cell 10 (26) +18%	Cell 11 (27) +10%
Cell 4 (20) +4%	Cell 5 (21) +15%	Cell 6 (22) +13%	Cell 7 (23) +21%
Cell 0 (16) +8%	Cell 1 (17) +20%	Cell 2 (18) +14%	Cell 3 (19) +22%
Cell 32 (34) +10%	Cell 33 (35) +12%		

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NS 14678

Figure 1.2-14 - Example of Lean Exhaust – All Cells

Cell 12 (28) +1%	Cell 13 (29) +1%	Cell 14 (30) 0%	Cell 15 (31) 0%
Cell 8 (24) +1%	Cell 9 (25) 0%	Cell 10 (26) 0%	Cell 11 (27) -1%
Cell 4 (20) +4%	Cell 5 (21) -1%	Cell 6 (22) 0%	Cell 7 (23) +2%
Cell 0 (16) 0%	Cell 1 (17) +3%	Cell 2 (18) +1%	Cell 3 (19) -2%
Cell 32 (34) +1%	Cell 33 (35) -2%		

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NS 14434

Figure 1.2-13 - Typical Adaptive Memory Values

Cell 12 (28) -5%	Cell 13 (29) -4%	Cell 14 (30) -8%	Cell 15 (31) -3%
Cell 8 (24) -9%	Cell 9 (25) -6%	Cell 10 (26) -10%	Cell 11 (27) -1%
Cell 4 (20) -4%	Cell 5 (21) -1%	Cell 6 (22) -7%	Cell 7 (23) -20%
Cell 0 (16) -10%	Cell 1 (17) -30%	Cell 2 (18) -13%	Cell 3 (19) -2%
Cell 32 (34) -12%	Cell 33 (35) -24%		

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NS 14980

Figure 1.2-15 - Example of Rich Exhaust – All Cells

1.3 EVAPORATIVE EMISSION CONTROL SYSTEM

GENERAL DESCRIPTION

PURPOSE

The evaporative emission control system used is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon (charcoal) storage device (canister) to hold the vapors when the engine is not operating (Figure 1.3-3). The purpose of the canister purge control system is to control the release of fuel vapors from the vapor collection canister into the engine intake manifold, so they are burned in the combustion process. This control is accomplished by using an electrically operated pulse width modulated solenoid valve. When the solenoid is energized, the purge valve is open, allowing the fuel vapor to enter the intake manifold. When the valve is de-energized, the purge valve is closed.

EVAPORATIVE SYSTEM

Gasoline vapors from the fuel tank flow into the tube labeled "FROM FUEL TANK" (Figure 1.3-1). These vapors are absorbed into the granulated carbon. The canister is purged (by electronic control module control) when the engine has been running for a specified amount of time. Air is drawn into the canister through the air inlet port (Figure 1.3-1). The air mixes with the vapor and the mixture is drawn into the intake manifold.

OPERATION

The electronic control module operates a pulse width modulated solenoid valve, which controls intake manifold vacuum to the charcoal canister. The solenoid is opened and closed 16 times a second (16 HZ) to meter the purge flow. This is electronic control module controlled, and may occur only during "Closed Loop" fuel control operation. The higher the air flow the more purge flow is allowed. The Tech 1 diagnostic tool has the ability to display the pulse width modulated control signal, in percentage of duty cycle "ON-Time." Zero percent (0%) would indicate the canister is NOT being purged of fuel vapor. 100% would indicate maximum purge is taking place.

The electronic control module turns "On" the solenoid valve and allows purge when:

- Engine coolant temperature is more than 80°C.
- Fuel control system is operating in "Closed Loop" mode.

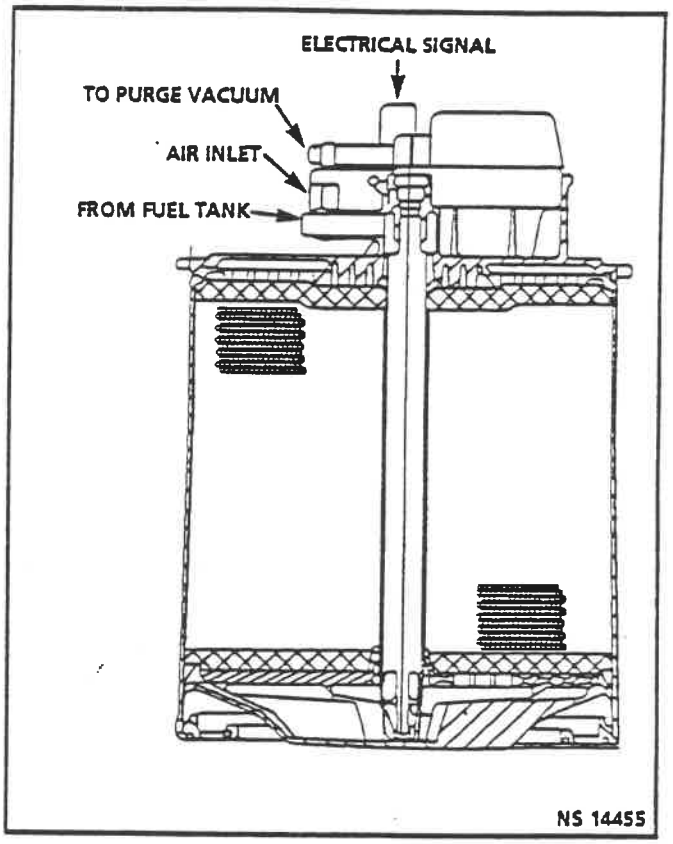


Figure 1.3-1 Vapor Canister

- Vehicle speed is more than 21 km/h. When energized vehicle speed criteria changes to keep purge system active down to 9 km/h.
- Throttle position is more than 2%. Once energized, throttle position will not be a factor unless more than 99%. Then the wide open throttle indicator will de-energize the canister purge solenoid.

RESULTS OF INCORRECT OPERATION

- Poor idle, stalling and poor driveability can be caused by:
  - Malfunctioning purge solenoid.
  - Damaged canister.
  - Hoses split, cracked and/or not connected to the proper tubes.
  - Pinched or plugged hose.

VISUAL CHECK OF CANISTER

- Solenoid properly mounted and O-ring in place.
- Cracked or damaged, replace canister.
- Fuel leaking from bottom of canister, replace canister and check hoses and hose routing.

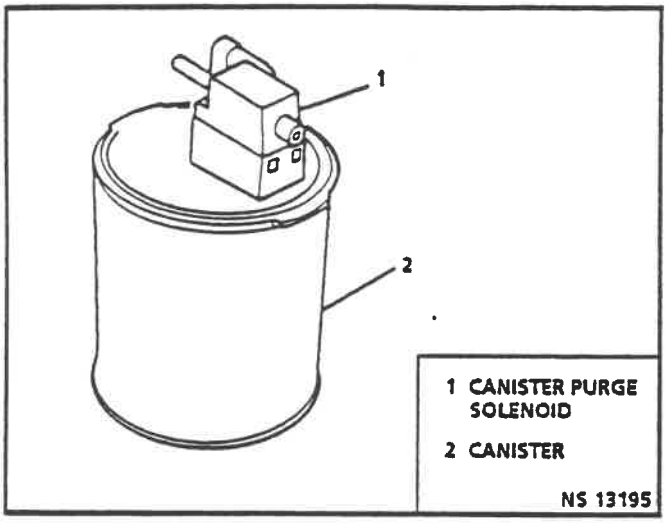


Figure 1.3-2 Canister Purge Solenoid

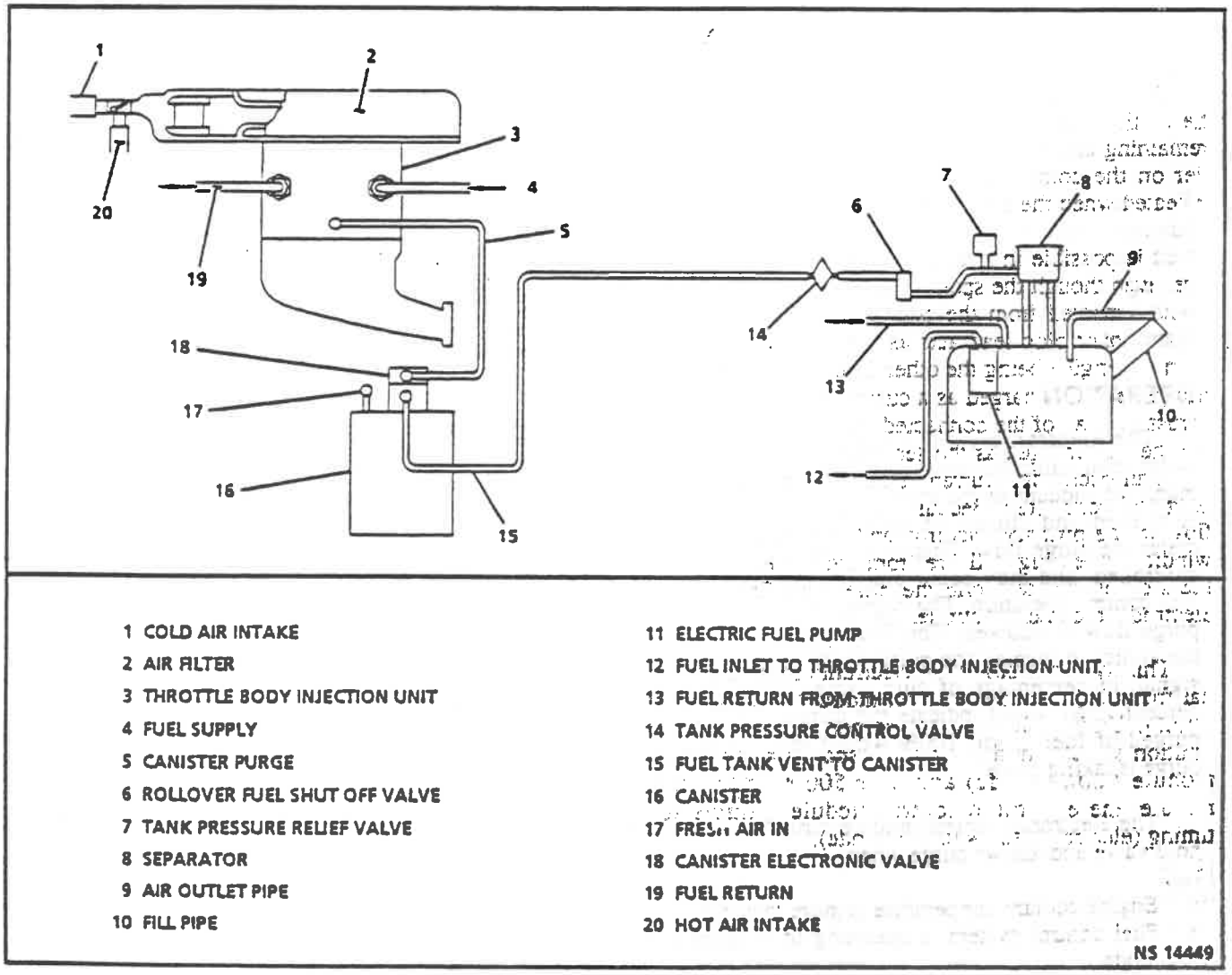

1 COLD AIR INTAKE
2 AIR FILTER
3 THROTTLE BODY INJECTION UNIT
4 FUEL SUPPLY
5 CANISTER PURGE
6 ROLLOVER FUEL SHUT OFF VALVE
7 TANK PRESSURE RELIEF VALVE
8 SEPARATOR
9 AIR OUTLET PIPE
10 FILL PIPE
11 ELECTRIC FUEL PUMP
12 FUEL INLET TO THROTTLE BODY INJECTION UNIT
13 FUEL RETURN FROM THROTTLE BODY INJECTION UNIT
14 TANK PRESSURE CONTROL VALVE
15 FUEL TANK VENT TO CANISTER
16 CANISTER
17 FRESH AIR IN
18 CANISTER ELECTRONIC VALVE
19 FUEL RETURN
20 HOT AIR INTAKE
NS 14449

Figure 1.3-3 Evaporative Emission Control System

1.4 DIRECT IGNITION SYSTEM

GENERAL DESCRIPTION

SYSTEM OPERATION

The direct ignition system does not use the conventional distributor and ignition coil. This ignition system consists of two separate ignition coils, a direct ignition system ignition module and crankshaft sensor as well as the related connecting wires and the electronic spark timing portion of the electronic control module (Figure 1.4-1). It has no moving parts, and so requires no maintenance. It also has no adjustment, as ignition timing is totally electronically controlled.

A distributorless ignition system such as this one uses a "waste spark" method of spark distribution. Each cylinder is paired with the cylinder that is opposite it (1-4 or 2-3). The spark occurs simultaneously in the cylinder coming up on the compression stroke and in the cylinder coming up on the exhaust stroke.

The cylinder on the exhaust stroke requires very little of the available energy to fire the spark plug. The remaining energy will be used as required by the cylinder on the compression stroke. The same process is repeated when the cylinders reverse roles.

It is possible in a no load condition for one plug to fire, even though the spark plug lead from the same coil is disconnected from the other spark plug. The disconnected spark plug lead acts as one plate of a capacitor, with the engine being the other plate. These two "capacitor plates" are charged as a current surge (spark) jumps across the gap of the connected spark plug. The "plates" are then discharged as the secondary energy is dissipated in an oscillating current across the gap of the spark plug still connected. Because of the direction of current flow in the primary winding, and thus in the secondary winding, one plug will fire from the center electrode to the side electrode while the other will fire from side electrode to center electrode.

This system utilizes the electronic spark timing signal from the electronic control module to control spark timing. Under 500 revolutions per minute, the direct ignition system module controls spark timing (ignition module timing mode) and over 500 revolutions per minute, the electronic control module controls spark timing (electronic spark timing mode).

To properly control ignition timing, the electronic control module relies on the following information:

- Engine speed (revolutions per minute).
- Engine load (manifold absolute pressure.
- Atmospheric (barometric) pressure.
- Engine coolant temperature.
- Intake air temperature.
- Crankshaft position.

ELECTRONIC SPARK TIMING
Figure 1.4-1

Following is a brief description for each of the four electronic spark timing circuits, between the ignition module and electronic control module.

- **Crankshaft Reference Input Signal - Circuit 42.**

  The crankshaft sensor generates signals to the ignition module, which results in reference pulses being sent to the electronic control module. The electronic control module uses these signal pulses to calculate crankshaft position and engine speed and injector pulse width.

- **Reference Low - Circuit 58.**

  This wire is grounded only through the module and ensures that the ground circuit has no voltage drop between the ignition module and the electronic control module, which could affect performance.

- **Bypass Mode Control - Circuit 39.**

  At about 500 revolutions per minute, the electronic control module applies 5 volts to this circuit to switch spark timing control from the direct ignition system module to the electronic control module. This circuit could be considered a "mode control" circuit for the ignition system. The two modes of ignition system operation are ignition module control mode, sometimes called the "bypass mode," and electronic control module mode, sometimes called "electronic spark timing mode."

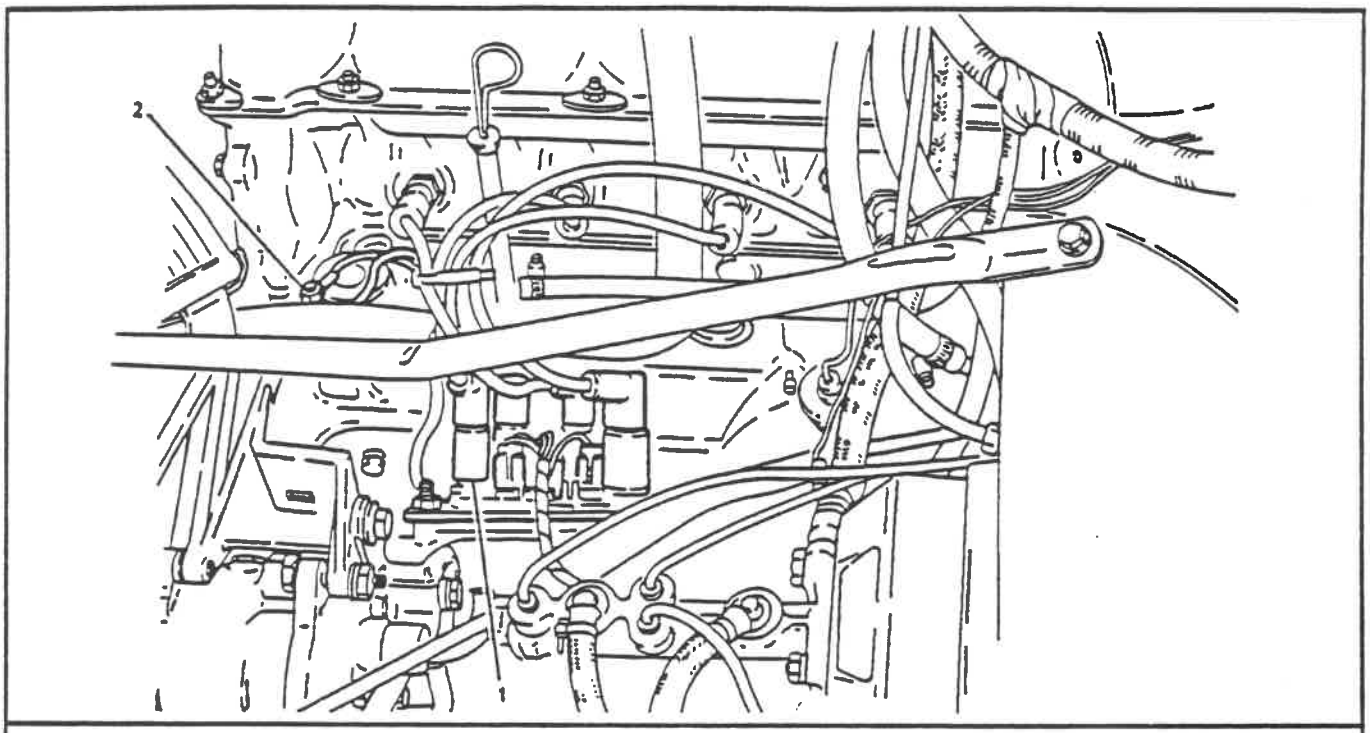


Figure 1.4-1 Ignition Coils, Wires, Module and Ground Points

- Electronic Spark Timing Output - Circuit 40.

  The direct ignition system module sends a reference signal to the electronic control module when the engine is cranking. While the engine is under 500 revolutions per minute, the direct ignition system module controls the ignition timing. When the engine speed exceeds 500 revolutions per minute, the electronic control module applies 5 volts to the bypass mode control circuit to switch the ignition system to electronic control module control (electronic spark timing mode). When the ignition system is operating in the "electronic spark timing mode," the output signal on Circuit 40 from the electronic control module to the ignition module is totally responsible for spark timing and ignition dwell time.

SYSTEM COMPONENTS

Crankshaft Sensor

Figures 1.4-2 and 1.4-3

This system uses a magnetic crankshaft sensor mounted within approximately 1 mm of the crankshaft reluctor. The reluctor is a special wheel attached to the front of the crankshaft with seven slots machined into it, six of which are equally spaced (60° apart). A seventh slot is spaced 10° from one of the other slots and serves

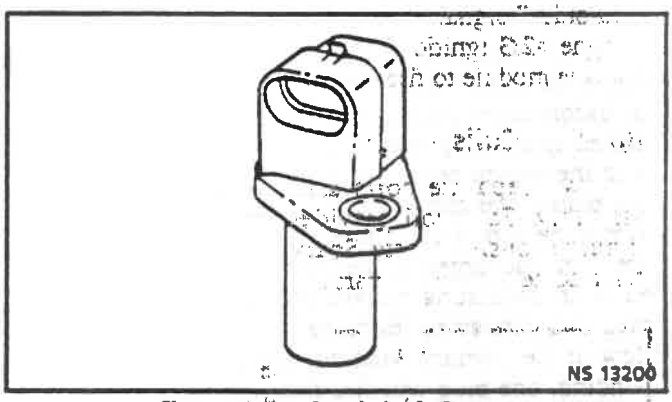


Figure 1.4-2 Crankshaft Sensor

to generate a "synchronization-pulse." As the reluctor wheel rotates as part of the crankshaft, the slots change the magnetic field of the sensor, creating an induced voltage pulse.

Based on the crank sensor pulses, the direct ignition system module sends reference signals to the electronic control module which are used to indicate crankshaft position and engine speed. The direct ignition system module will continue to send these reference pulses to the electronic control module at a rate of one per each 180° of crankshaft rotation.

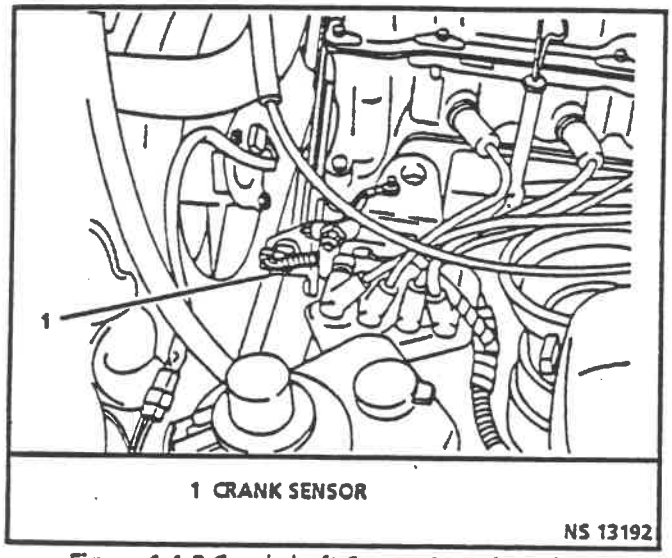


Figure 1.4-3 Crankshaft Sensor Location View

The electronic control module will activate the fuel injector based on the recognition of each reference pulse sent from the ignition module. By comparing the time between pulses, the direct ignition system module can recognize the pulse representing the seventh slot (synchronization pulse) which starts the calculation of ignition coil sequencing.

The second crank pulse following the "synchronization-pulse" signals the direct ignition system module to fire the #2/3 ignition coil and the fifth crank pulse signals the module to fire the #1/4 ignition coil.

Ignition Coils

Two separate coils are mounted to the module assembly. Each coil provides the spark for two plugs simultaneously (Waste Spark Distribution). Each coil can also be replaced separately (Figure 1.4-4).

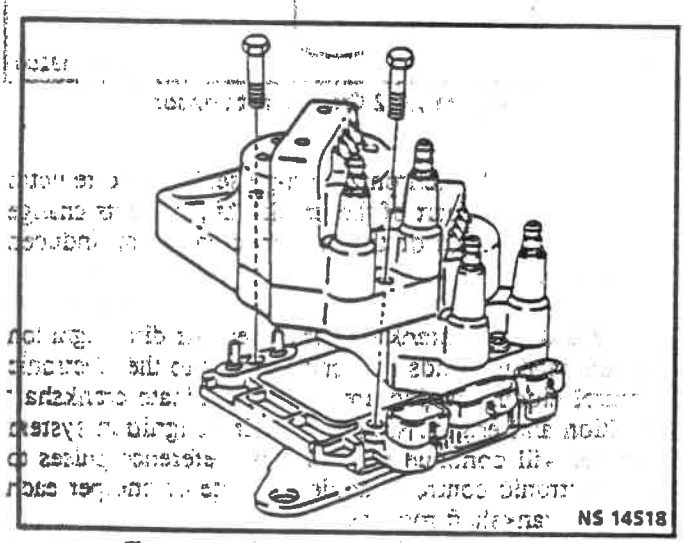


Figure 1.4-4 Ignition Coil Replacement

Direct Ignition System Module

The direct ignition system module monitors the crank sensor signals and based on these signals sends a reference signal to the electronic control module so that correct spark and fuel injector control can be maintained during all driving conditions. During cranking, the direct ignition system module monitors the "synchronization-pulse" to begin the ignition firing sequence. Below 500 revolutions per minute the ignition module controls spark advance by triggering each of the two coils at a predetermined interval based on engine speed only. Above 500 revolutions per minute the electronic control module controls the spark timing (electronic spark timing mode) and compensates for all driving conditions. The direct ignition system module must receive a "sync-pulse" and then a crank signal in that order to enable the engine to start.

The direct ignition system module has no moving parts and therefore is not repairable. If the module is found to be defective it can be replaced. When a module is replaced, the remaining direct ignition system components including the ignition coils (Figure 1.4-4) must be transferred to the new module.

DIAGNOSIS

SYMPTOM DIAGNOSIS

An open or ground in the electronic spark timing output circuit will result in the engine continuing to run, but in ignition module control mode at a calculated timing value and the "Check Engine" light will not be "ON." If the electronic spark timing output circuit fault is still present the next time the engine is restarted, a Code 42 will be set and the engine will operate in the ignition module control mode. This may cause poor performance and reduced fuel economy.

How Code 42 Is Determined

The electronic spark timing output circuitry in the electronic control module issues electronic spark timing output pulses *anytime* crankshaft reference signal input pulses are being received. When the ignition system is operating in the ignition module mode (no voltage on the bypass mode control circuit), the ignition module grounds the electronic spark timing pulses sent from the electronic control module. The ignition module will remove the ground path for the electronic spark timing pulses only after switching to the electronic spark timing mode. *(The electronic control module commands the switching between ignition module and electronic spark timing modes, via the bypass mode control circuit to the ignition module.)*

The electronic control module monitors its electronic spark timing output, and expects to see no pulses on the electronic spark timing output circuit when it has not supplied the 5 volts on the bypass mode control circuit.

When the correct engine speed for electronic spark timing operation is reached *(more than 500 revolutions per minute)*, the electronic control module applies 5 volts to the bypass mode control circuit, and the electronic spark timing pulses should no longer be grounded by the ignition module. The electronic control module constantly monitors its electronic spark timing output circuit, and should "see" the electronic spark timing pulses only when in the "electronic spark timing mode."

If electronic spark timing output circuit is open, the electronic control module will detect electronic spark timing output pulses while attempting to start the engine *(in the ignition module mode)* due to the ignition module not being able to ground the electronic spark timing pulses. Three things will occur: 1) a Code 42 will set; 2) the electronic control module will not apply 5 volts to the bypass mode control circuit, and 3) the engine will start and run in the ignition module control mode.

If electronic spark timing output circuit is grounded, the electronic control module would not detect a problem until the change to electronic spark timing mode happens. When the electronic control module applies 5 volts to the bypass mode control circuit, the ignition module will switch to the electronic spark timing mode. If the electronic spark timing output circuit is grounded, there would be no electronic spark timing pulses for the ignition module to trigger the ignition coils with and the engine may falter. The electronic control module will quickly revert back to the ignition module mode *(turn "OFF" the 5 volts on the bypass mode control circuit)*, Code 42 will set, and the ignition system will operate in the ignition module control mode until the fault is corrected and the engine is stopped and restarted.

If bypass mode control circuit is open -OR- grounded, the ignition module can not switch to the electronic spark timing mode. In this case, the electronic spark timing pulses will stay grounded by the ignition module, and Code 42 will be set. The engine will start and run in the ignition module mode.

Results of Incorrect Operation

An open or ground in the electronic spark timing or bypass mode control circuit will set a Code 42. If a fault occurs in the electronic spark timing output circuit when the engine is running, the engine may falter or quit running but will restart and run in the ignition module mode. A fault in either circuit will force the ignition system to operate on ignition module mode timing, which will result in reduced performance and fuel economy.

The electronic control module uses information from the manifold absolute pressure and coolant temperature sensors in addition to revolutions per minute to calculate the main spark advance values as follows:

High revolutions per minute ..... = more advance

Low manifold absolute pressure volts *(low engine load)* ..... = more advance

Cold engine ..... = more advance

Low revolutions per minute ..... = less advance

High manifold absolute pressure volts.. = less advance *(high engine load)*

Hot engine ..... = less advance

Therefore, detonation could be caused by incorrect low manifold absolute pressure sensor output voltage or incorrect high resistance in the coolant temperature sensor circuit. Poor performance could be caused by incorrect high manifold absolute pressure output voltage or incorrect low resistance in the coolant temperature sensor circuit.

1.9 ELECTRONIC CONTROL MODULE-CONTROLLED INTAKE MANIFOLD ELECTRIC HEATER

GENERAL DESCRIPTION

An intake manifold electric heating element (Figure 1.9-1) is used on the 1.7L throttle body injection engine to provide a source of rapid heat to the engine intake system during cold operation. Rapid heating is desirable because it provides quick fuel evaporation, and a more uniform fuel distribution which aids cold driveability, and reduced exhaust emissions.

The heater is self-current limiting; as its temperature increases, its resistance increases. Increased resistance prevents thermal overheat, with a possible resultant short to ground.

OPERATION

The manifold heater, mounted into the bottom of the intake manifold directly under the throttle body injection unit, is switched "ON" and "OFF" by the electronic control module (Figure 1.9-2).

The electronic control module switches "ON" the heater by grounding the manifold heater relay control circuit when all the following conditions exist:

- Coolant temperature sensor input is less than 65°C.
  AND
- Intake air temperature sensor input is less than 80°C.
  AND
- Battery voltage is greater than 8 volts.

The above conditions are present in a cold, running engine with minimal accessory load.

The electronic control module switches "OFF" the manifold heater after it has been "ON," if any of the following conditions exist:

- Coolant temperature sensor input is greater than or equal to 65°C.
  OR
- Battery voltage is less than 6 volts
- Intake air temperature input is greater than 80°C.

The above conditions are present in a warm engine and/or with a heavy electrical accessory load.

SPECIAL NOTE

The manifold heater draws a large amount of electrical current when first energized, as much as 60 amps for a few seconds. The current requirements quickly reduce as the heating element warms and stabilizes at approximately 20 amps. The manifold heater is also energized when the electronic control module is operating in the "Diagnostic Mode." This is described in "Diagnosis," Section "2".

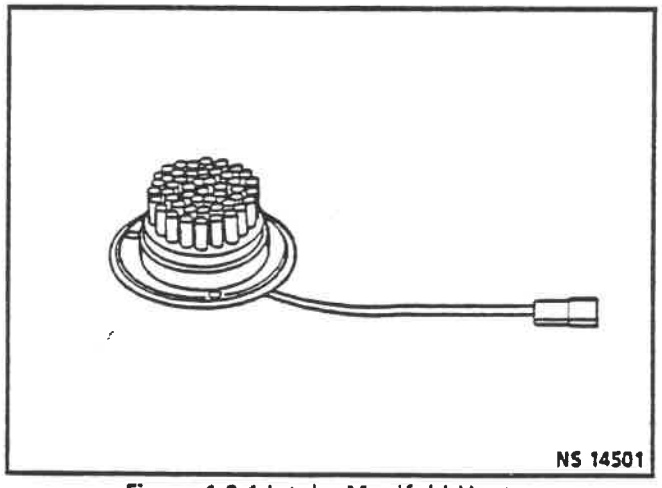


Figure 1.9-1 Intake Manifold Heater

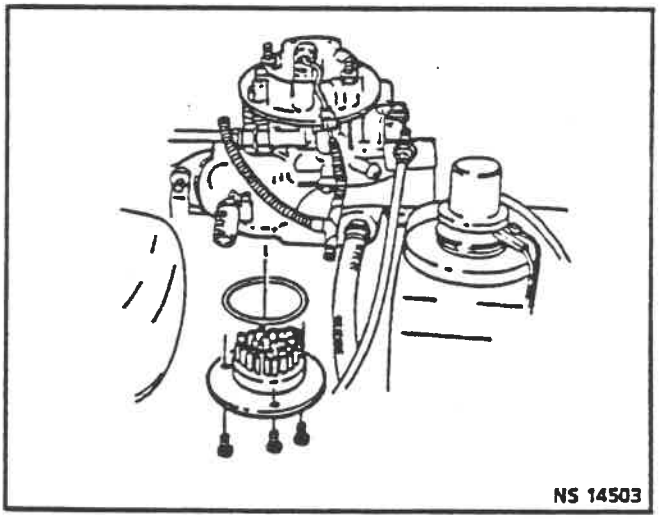


Figure 1.9-2 Intake Manifold Heater Location View

1.10 ELECTRONIC CONTROL MODULE-CONTROLLED AIR CONDITIONING

GENERAL DESCRIPTION

To improve idle quality and wide open throttle performance, the air conditioning compressor is controlled by the electronic control module (Figure 1.10-1).

The system is made up of an air conditioning cycling switch, high-pressure switch, high coolant temperature switch, air conditioning compressor clutch control relay (relay 2), control unit relay (relay 1), condenser fan relay (relay 3), blower switch, the compressor and instrument panel switch.

The electronic control module monitors the air conditioning evaporative temperature cycling switch, and the air conditioning instrument panel switch and regulates the air conditioning compressor load on the engine through the air conditioning compressor clutch control relay.

The electronic control module can anticipate the air conditioning compressor's load and will remove or delay adding the load if:

- Throttle position sensor is above a set value or angle.
- Coolant temperature sensor is above a set value or temperature.
- The load already on the engine is above a set value based upon vehicle speed and throttle position angle.
- The engine exceeds a certain speed (high revolutions per minute).
- The engine speed is too low to prevent a condition that could cause the engine to stop.

Other Special Conditions:

The electronic control module will de-energize the air conditioning clutch via the air conditioning clutch control relay if the battery voltage is greater than 16.9 volts.

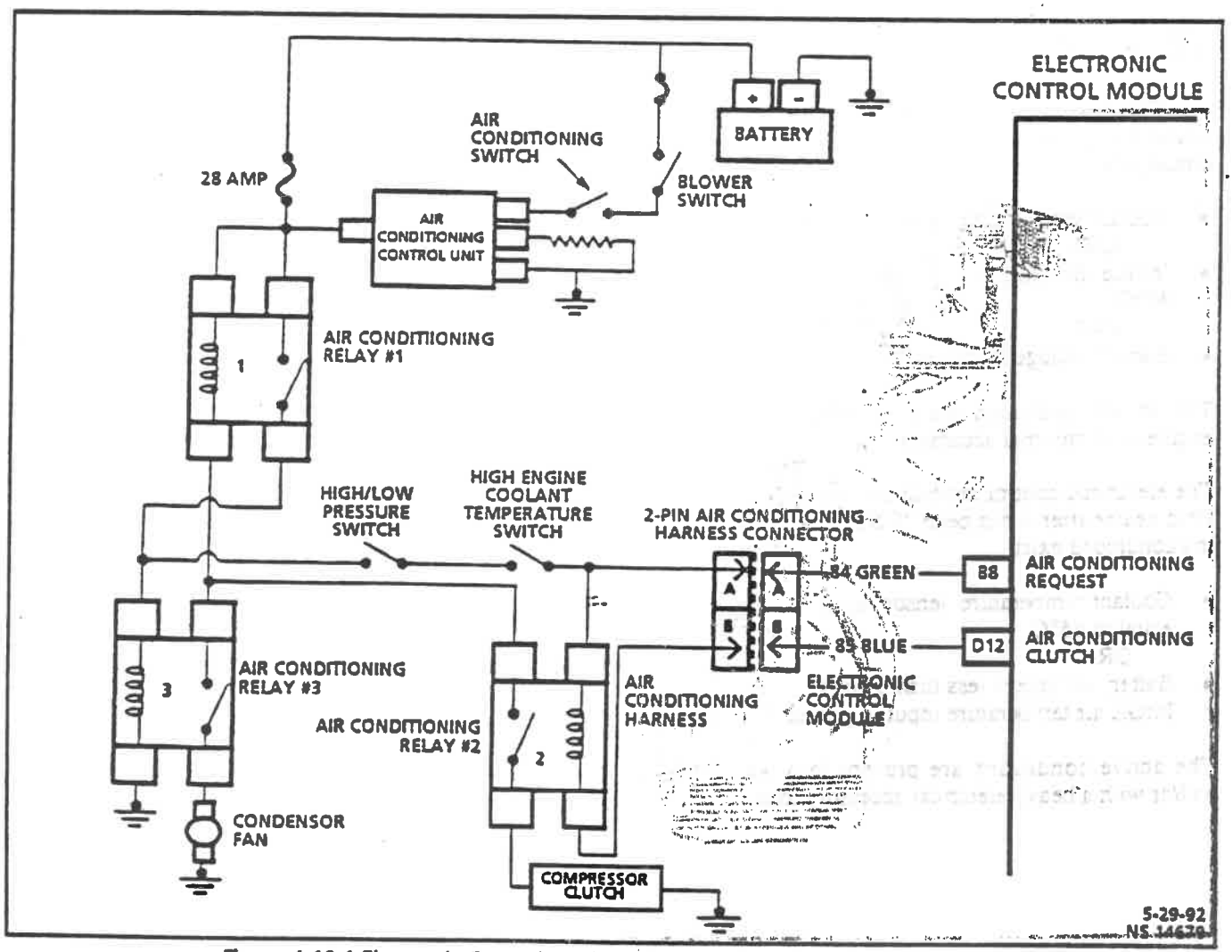


Figure 1.10-1 Electronic Control Module Controlled Air Conditioning Circuit

1.13 CRANKCASE VENTILATION SYSTEM

GENERAL DESCRIPTION

A crankcase ventilation system (Figure 1.13-1) is used to provide more complete scavenging of crankcase vapors. Unlike some ventilation systems, the throttle body injection system does not supply fresh air to the crankcase.

The crankcase ventilation system has two circuits, a primary and secondary circuit. In both circuits the gas and oil vapors from the crankcase are returned to the combustion chambers through an oil separator located on the engine block near the direct ignition system module.

The primary circuit consists of a calibrated orifice fitted into the throttle body injection unit. A small hose runs from this orifice and into the oil separator. A larger (secondary circuit) hose runs from the air cleaner to the oil separator. These hoses make up the two (primary/ secondary) circuits of this system.

At idle all crankcase vapors are directed through the primary circuit orifice (small hose), which will be experiencing high manifold vacuum. Under heavy load or wide open throttle conditions, a small amount of the crankcase vapors are passed through the primary system orifice. However, most of the gases pass through the secondary system (large hose) into the air cleaner, through the throttle body injection, and are burned in the combustion chamber.

RESULTS OF INCORRECT OPERATION

A plugged orifice or hoses may cause:

- Higher than normal idle air control valve steps.
- Oil leaks.
- Oil in air cleaner.
- Sludge in engine.

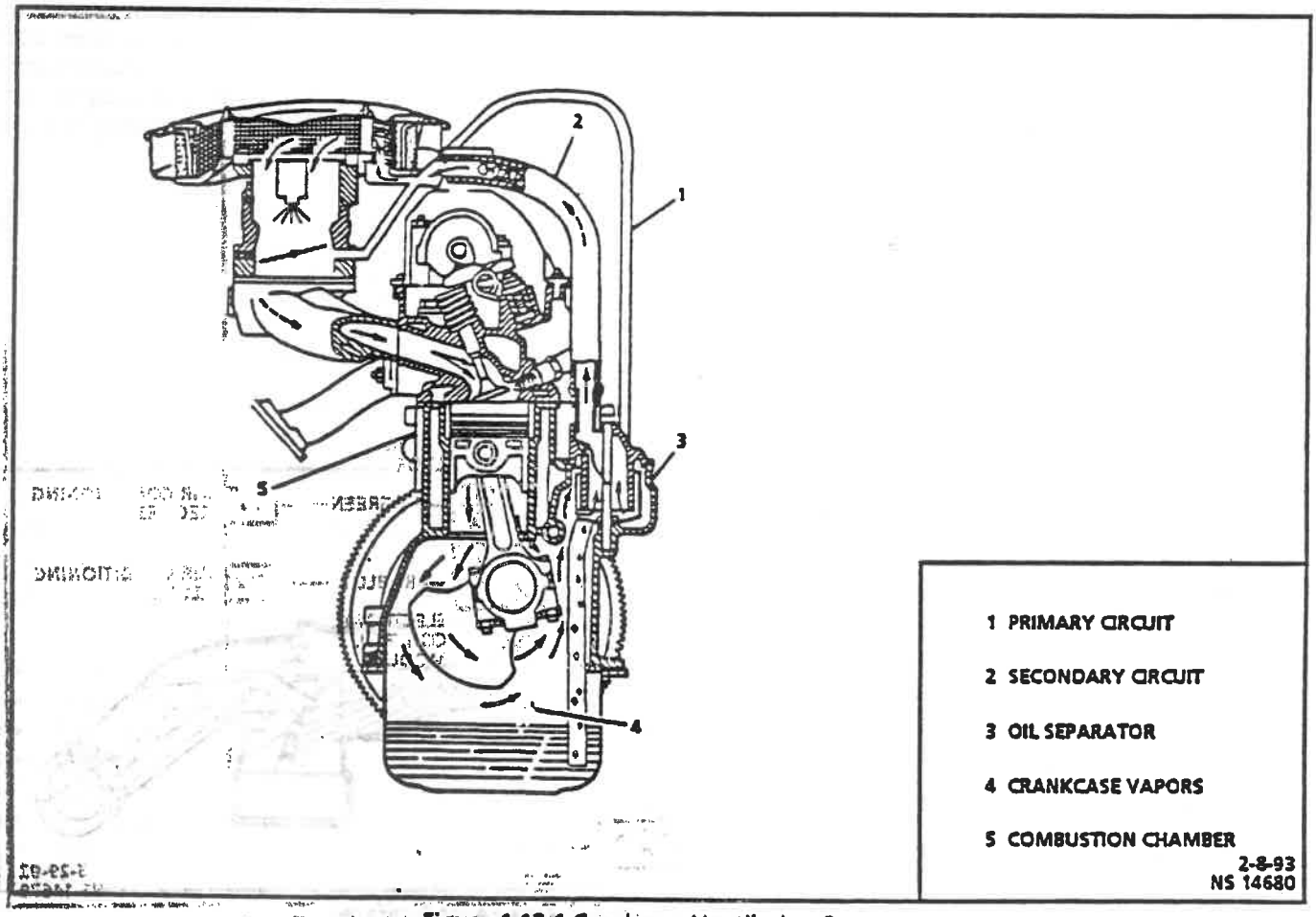


Figure 1.13-1 Crankcase Ventilation System

1.14 THERMOSTATIC AIR CLEANER

GENERAL DESCRIPTION

PURPOSE

A heated intake air system is used to give good driveability under varying climatic conditions. By having a uniform inlet air temperature, the fuel system can be calibrated to reduce exhaust emissions and to eliminate throttle valve icing.

OPERATION

The THERMOSTATIC air cleaner operates by heated air and a wax pellet motor similar to the one which operates the engine coolant thermostat. Air can enter the air cleaner from outside the engine compartment or from a heat stove built around the exhaust manifold.

- Hot Air Delivery Mode. When the temperature is below 30°C, the wax pellet contracts and the damper door will be shutting off outside air and allowing only heated air from the exhaust manifold to enter the air cleaner.
- Outside Air Delivery Mode. When the temperature is above approximately 55°C, the damper door drops down and only outside air enters the air cleaner.
- Regulating Mode. Between approximately 30°C and 55°C the damper door allows both heated and outside air to enter the air cleaner.

RESULTS OF INCORRECT OPERATION

- Hesitation during warm-up can be caused by:
  - Heat stove tube disconnected.
  - Door tension spring not operating.
  - Wax pellet not operating.
  - Damper door does not move.
  - Missing air cleaner to throttle body injection seal.
  - Loose air cleaner.
- Lack of power, sluggish, pinging (spark knock or detonation), on a hot engine can be caused by:
  - Damper door does not open to outside air.

THERMOSTATIC AIR CLEANER FUNCTIONAL CHECK

1. Inspect system to be sure heat stove tube is connected.
2. Check damper door in air cleaner for freedom of movement.
3. Check damper door tension spring is attached, and pulling the damper door to the wax pellet actuator.
4. Check for presence and condition of air cleaner to throttle body injection gasket and cover seal.
5. With air cleaner assembly installed, engine not running, damper door should be open to heat stove air when engine is cold.
6. Start engine. Watch damper door in air cleaner snorkel. When engine is first started, damper door should be closed to outside air. As air cleaner warms up (this will take several minutes depending on temperature), damper door should open slowly to allow outside air in.

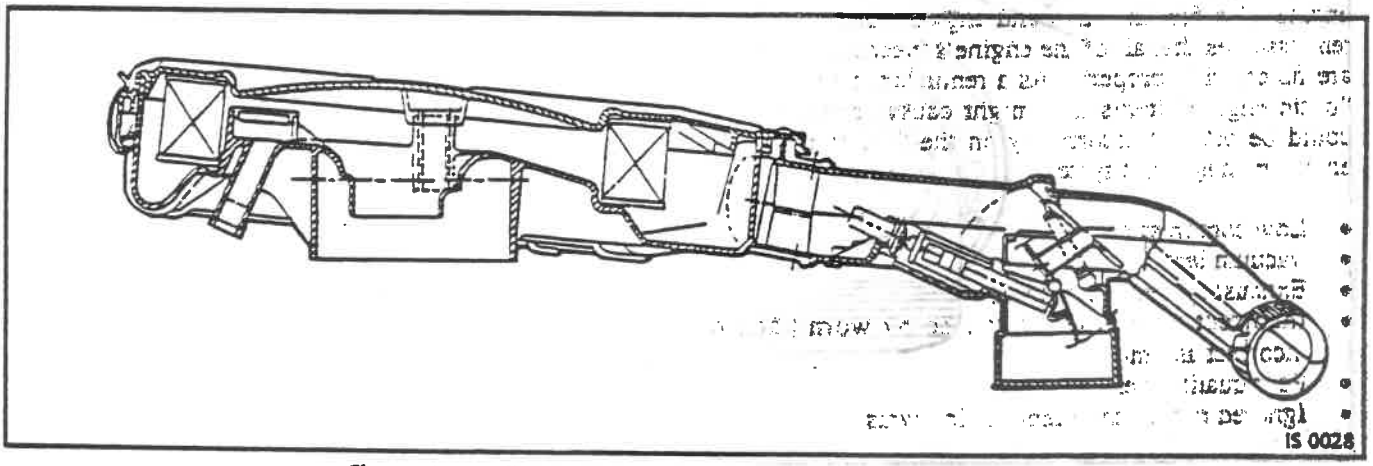


Figure 1.14-1 THERMAC Air Cleaner - Wax Pellet Operated

2. DIAGNOSIS

INTRODUCTION

Diagnosing the electronic fuel injection and engine management system is fairly straightforward if you use a sound diagnostic procedure.

The first and foremost order of importance, for diagnosing a problem with any type of system, is to understand how that system is supposed to normally operate. Whether it is an automotive system, a heating system for a building, or even a human biological system like your heart or lungs, before attempts are made to repair a problem, it is crucial to understand what is normal and what is not normal.

In other words, to be effective in diagnosing and repairing problems with the electronic fuel injection and engine management system, it is important that you possess a good working knowledge of the system.

Having the proper diagnostic tools and reference materials available, and attendance at training schools is a good method for planning to succeed when diagnosing problems or malfunctions with the engine management system.

This manual has a section specifically written to help in understanding how the system normally operates. The first section of this manual, Section "1", titled "General Description and System Operation," is a good place to begin your understanding of normal system and component operation. Make sure you take the time to read the material contained at least once.

The Importance of Mechanical Systems

Don't forget, underneath all the wiring, electronics, sensors, and actuators is a basic internal combustion engine. The fuel injection and engine management system assumes that all of the engine's mechanical systems are functioning properly. As a reminder, here are a few "basic engine" items that might cause conditions that could be blamed incorrectly on the "electronics," the engine management system:

- Low compression
- Vacuum leaks
- Exhaust system restrictions
- Incorrect valve timing caused by worn parts or incorrect assembly
- Poor quality fuel
- Ignored regular maintenance intervals

The Importance of Having the Special Diagnostic Tools

There are certain special diagnostic tools that are called out in the diagnostic procedures and charts. These tools are designed for specific diagnostic uses, and the service manual procedures and charts that call for their use are written to require having these tools available. If the special diagnostic tools are not used where indicated, most efforts to accurately diagnose problems with the engine management system will be extremely difficult, if not impossible. These special diagnostic tools have been carefully designed and selected, and are available as a diagnostic tool kit through Kent-Moore SPX Corporation. Address, FAX, and phone numbers are supplied in Section 6 - "Special Tools," of this manual.

As to special tools, it is important to remember that none of the special diagnostic tools will make you into a diagnostic genius. No tool will ever replace human intellect. Tools can't perform a diagnosis for you, and they don't eliminate the need for diagnostic charts and service procedures. All of the special diagnostic tools are just that—tools.

Tools are used to help perform various tasks. Some tools, such as the Tech 1 diagnostic tool or the digital volt-ohm-amp multimeter, allow us a way to examine what is happening in an electrical or electronic circuit. The Tech 1 diagnostic tool is by itself a small handheld computer, and communicates with the electronic control module. The Tech 1 allows us a way of "seeing" what the electronic control module is interpreting from its various input signals, and a "window" to observe what commands are being sent to the various devices that are controlled and operated by the electronic control module.

Knowledge required

It is *NOT* required that you fully understand how electronics and computers operate. What is required is a basic working knowledge of applied electrical theory, such as voltage, current, resistance, and what happens in an "open" circuit, and what happens in a "shorted" circuit. You should also be familiar with interpreting a simple wiring diagram. Also, you should be familiar with how to use a digital volt-ohm-amp multimeter in various situations. Of course, it is assumed that you have a good understanding of how a basic automotive engine operates.

The engine used in this vehicle has controls to reduce exhaust emissions while maintaining good driveability and fuel economy.

An electronic control module is the heart of this control system and has sensors used to get information about engine operation and about the various systems it controls. Details of basic operation are covered in Section "1", "General Description and System Operation."

The electronic control module has the ability to do some diagnosis of the engine management. When it finds a problem, it turns "ON" a "CHECK ENGINE" light on the instrument panel, and a trouble code will be stored in the electronic control module memory. *This does not mean that the engine should be stopped right away*, but that the cause of the light coming "ON" should be checked as soon as reasonably possible.

DIAGNOSIS PROCEDURE

This portion of Section "2", "Diagnosis" of the manual is divided into 5 parts. They are:

INTRODUCTION. This contains general information about how to use this section.

"A" SECTION AND "A-_" CHARTS. This is where all diagnostic procedures begin. It contains: the all-important "DIAGNOSTIC CIRCUIT CHECK"; charts about the "Check Engine" light; what to do if the engine will not run; and other general charts.

TROUBLE CODE CHARTS. If the DIAGNOSTIC CIRCUIT CHECK reveals a trouble code set in the electronic control module's memory, this is where the individual trouble codes are diagnosed. If more than one trouble code is stored, always start with the lowest number before going to the next higher trouble code.

"B" SECTION, DRIVEABILITY SYMPTOMS. If no trouble code is stored, or a code is stored but proves to be only an intermittent condition, this part will help the mechanic to find the problem. Again, all diagnostic procedures must begin with the DIAGNOSTIC CIRCUIT CHECK.

"C" SECTION AND "C-_" CHARTS (Component Systems). This part contains general remove and replace information about the individual components in the engine control system. It also contains service information about those components. This is where you would look to find information on: the ignition system; intake manifold electric heater system; the fuel injector; the air conditioning electrical control system; and so on.

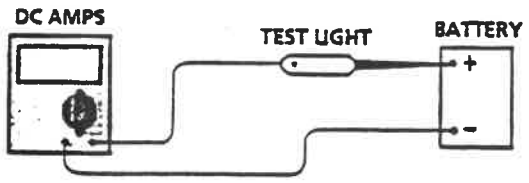
2.1 DIAGNOSTIC PRECAUTIONS

The following requirements must be observed when working on vehicles:

1. Before removing any electronic control module system component, disconnect the battery ground cable.
2. Never start the engine without the battery being solidly connected.
3. Never separate the battery from the on board electrical system while the engine is running.
4. When charging the battery, disconnect it from the vehicle's electrical system.
5. Never subject the electronic control module to temperatures above 80°C, i.e. paint oven. Always remove control unit first if this temperature is to be exceeded.
6. Ensure that all cable harness plugs are connected solidly and that battery terminals are thoroughly clean.
7. The engine management system harness connectors are designed to fit only one way; there are indexing tabs and slots on both halves of the connector. Forcing the connector into place is not necessary if it is installed with the proper orientation. Failure to match the indexing tabs and slots on the connector can cause damage to the connector, the module, or other vehicle components or systems.
8. Never connect or disconnect the electronic control module connectors when the ignition is switched "ON."
9. Before attempting any electric arc welding on the vehicle, disconnect the battery leads and the electronic control module connectors.
10. When steam cleaning engines, do not direct the steam cleaning nozzle at electronic control module system components. If this happens, corrosion of the terminals can take place.
11. Use only the test equipment specified in the diagnostic charts; other test equipment may give incorrect results or damage good components.
12. Make all voltage measurements using a digital voltmeter with an internal impedance rating of at least 10 million ohms per volt (10 mΩ/volt).
13. When a test light is specified, a "low-power" test light must be used. Do not use a high-wattage test light (i.e.: Headlight). While a particular brand of test light is not suggested, a simple check on any test light will ensure it is safe for electronic control module circuit testing. Connect an accurate ammeter (such as the high-impedance digital multimeter) in series with the test light, and power the test light-ammeter circuit with the vehicle battery.

If the ammeter indicates *less* than 1/4 amp current flow (.25 A or 250 ma), the test light is **SAFE** to use.

If the ammeter indicates *more* than 1/4 amp current flow (.25 A or 250 ma), the test light is **NOT SAFE** to use.



14. Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage from electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes as much as 4,000 volts for a person to even feel the zap of a static discharge.

    There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a car seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of ..ther type can cause damage, therefore, it is important to use care when handling and testing electronic components.

NOTICE: To prevent possible Electrostatic Discharge damage:

- Do Not touch the electronic control module connector pins or soldered components on the electronic control module circuit board. Never disassemble the electronic engine control module metal case, except for the calibrator cover.
- When handling an engine calibrator, do not remove the integrated circuit from carrier.

2.2 DIAGNOSTIC GENERAL DESCRIPTION

The diagnostic charts and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination. The charts assume the vehicle functioned correctly at the time of assembly and there are no multiple failures.

The electronic control module performs a continual self-diagnosis on certain control functions. This diagnostic capability is aided by the diagnostic procedures in this manual. The electronic control module's language for communicating the source of a malfunction is a system of diagnostic codes. The codes are two digit numbers that range from 12 to 55. When a malfunction is detected by the electronic control module, a code is stored/logged and the "Check Engine" light is turned "ON."

"CHECK ENGINE" LIGHT

The light is in the instrument panel and does the following:

- It tells the driver a problem has occurred and the vehicle should be taken for service as soon as reasonably possible. *It does NOT mean the engine should be stopped.*
- It displays diagnostic "Codes" stored by the electronic control module which help the technician diagnose system problems.

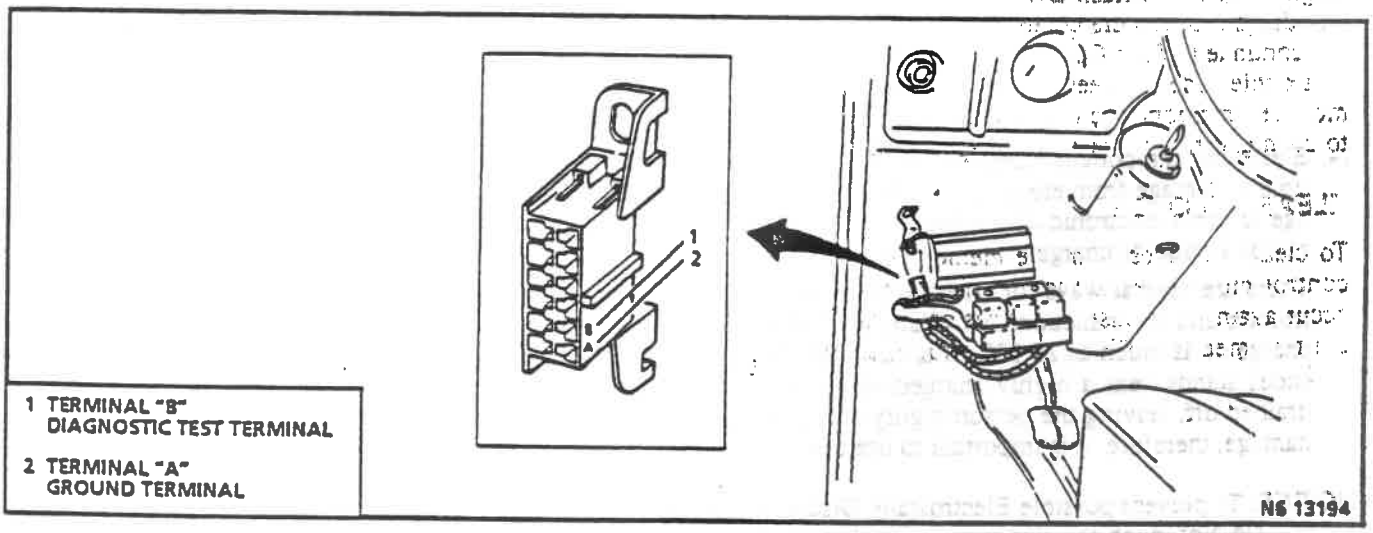
As a bulb and system check, the light will come "ON" with the ignition "ON," and the engine not running. When the engine is started, the light will turn "OFF." If the light remains "ON," the self-diagnostic system has detected a problem. If the problem goes away, the light will turn "OFF" in most cases after 10 seconds, but a diagnostic code will be stored in the electronic control module's memory.

When the light remains "ON" while the engine is running, or when a malfunction is suspected due to a driveability or emissions problem, a **"Diagnostic Circuit Check" must be performed.** The procedures for these checks are given in "Diagnostic Charts," Section "2.9A". These checks will expose malfunctions which may not be detected if other diagnostics are performed out of order.

INTERMITTENT "CHECK ENGINE" LIGHT

In the case of an "intermittent" problem, the "Check Engine" light will turn "ON" for at least ten (10) seconds and then will turn "OFF." However, the matching code will be stored in the memory of the electronic control module until the battery voltage to the electronic control module has been removed or the Tech 1 diagnostic tool has been used to "clear codes." When unexpected codes appear during the code reading process, one can assume these codes were set by an intermittent malfunction and could be helpful in diagnosing the system.

An intermittent code may or may not re-set. *If it is an intermittent failure, a Diagnostic Code Chart is not used.* Consult the "Diagnostic Aids" on the page facing the diagnostic chart corresponding to the intermittent diagnostic code. "Symptom Charts," Section "2.9B" also covers the topic of "Intermittents." A physical inspection of the sub-system often will reveal the problem.



1 TERMINAL "B"
DIAGNOSTIC TEST TERMINAL

2 TERMINAL "A"
GROUND TERMINAL

Figure 2.2-1 Assembly Line Data Link Location View

READING CODES

The provision for communicating with the electronic control module is the assembly line data link connector (see Figure 2.2-1). The assembly line data link connector is used by the assembly plant to receive electronic control module information, and to check the engine before the vehicle leaves the plant. The code(s) stored in the electronic control module's memory can be read either through a Tech 1 (a handheld diagnostic tool plugged into the assembly line data link connector), or by counting the number of flashes of the "Check Engine" light when the diagnostic "test" terminal "B" of the assembly line data link connector is grounded. The assembly line data link connector terminal "B" (diagnostic "test" terminal) is the second terminal from the right of the assembly line data link connector's top row. The terminal is most easily grounded by connecting it to terminal "A" (connected to engine ground), the terminal to the right of terminal "B" on the top row of the assembly line data link connector.

Once terminals "A" and "B" have been connected, the ignition switch must be moved to the "ON" position, with the engine NOT RUNNING. At this point, the "Check Engine" light should flash Code 12 three times consecutively. This would be the following flash sequence: "flash, pause, flash-flash, long pause, flash, pause, flash-flash, long pause, flash, pause, flash-flash." Code 12 is not a trouble code, Code 12 merely indicates that the electronic control module's diagnostic system is operating. If Code 12 is NOT indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the "Diagnostic Circuit Check" chart in "Diagnostic Charts," Section "2.9A".

Following the flashing of Code 12, the "Check Engine" light will flash any trouble codes three times if any diagnostic trouble codes are present, or it will simply continue to flash Code 12. If more than one diagnostic trouble code has been stored in the electronic control module's memory, the codes will flash from the lowest to the highest, with each code displayed three times.

CLEARING CODES

To clear the codes from the memory of the electronic control module, either to see if the malfunction will occur again or because repair has been completed, there are two methods. Either the electronic control module power feed must be disconnected for at least ten (10) seconds, or the Tech 1 diagnostic tool also has the ability to "erase" the diagnostic trouble codes from the electronic control module's memory without disconnecting the battery or any fuses. The electronic control module power feed can be disconnected by removing the negative battery terminal. (When the battery terminal is disconnected, other on-board memory data, such as preset electronic radio tuning, is also lost.)

NOTICE: To prevent electronic control module damage, the ignition must be "OFF" when disconnecting or reconnecting electronic control module power.

DIAGNOSTIC DISPLAY MODE

When the diagnostic "test" terminal is grounded (assembly line data link terminal "B" connected to "A") with the ignition "ON" and the ENGINE "STOPPED," the system will enter what is called the "Diagnostic Display" mode. (This can also be done by using the Tech 1 tool in the "F1: Field Service" mode, but with the *engine not running*.) In this mode the electronic control module will:

1. Display a Code 12 by flashing the "Check Engine" light (indicating the system is operating correctly).
2. Display any stored codes by flashing the "Check Engine" light. Each code will be flashed three times, then Code 12 will be flashed again. If no other codes are in the electronic control module's memory, Code 12 will continue to flash as long as the diagnostic display mode is active.
3. Energize the intake manifold heater relay, air conditioning clutch control relay and evaporative canister purge solenoid. This allows checking circuits which may be difficult to energize without driving the vehicle and being under particular operating conditions. These relays and solenoids will remain energized as long as the electronic control module is in the "Diagnostic Display" mode, including the intake manifold electric heater relay, which causes a high electrical load due to the manifold heater operating current.
4. Command the idle air control valve to fully extend to its zero-step position, shutting the idle air passage in the throttle body.

FIELD SERVICE MODE

If the diagnostic "test" terminal is grounded, or "Field Service" mode is selected from Tech 1 with the **ENGINE RUNNING**, the system will enter the "Field Service" mode. In this mode:

1. The "Check Engine" light will not flash malfunction codes. It will flash in a different manner, telling the technician if the fuel control system is operating in the "Open Loop" or "Closed Loop" mode. If in the "Closed Loop" mode, the flashing of the light will indicate if the exhaust is too rich, too lean, or in control. The explanation of each of the 4 possibilities follow.

   1A. **Flashing "Open Loop"** - The "Check Engine" light will flash "ON" and "OFF" 2.5 times per second (5 times every 2 seconds).

   1B. **Flashing "Closed Loop" with fuel system operating normally** - The "Check Engine" light will flash "ON" and "OFF" at a rate of once per second.

   1C. **Flashing "Closed Loop" but oxygen sensor input indicates a lean exhaust** - The "Check Engine" light will be "OFF" most or all of the time.

   1D. **Flashing "Closed Loop" but oxygen sensor input indicates a rich exhaust** - The "Check Engine" light will be "ON" most or all of the time.

2. The electronic spark timing is fixed at 10° before top dead center when engine revolutions per minute is less than 2,000.
3. The idle air control valve is commanded to a fixed number of steps.
4. Prevent any new diagnostic trouble codes from storing into memory.

See Sections "1.1" or "2.3" for additional information on electronic control module modes of operation.

ELECTRONIC CONTROL MODULE ADAPTIVE LEARNING ABILITY

The electronic control module has a "learning" ability which allows it to make corrections for minor variations in the engine management system to improve driveability. If the battery is disconnected to clear diagnostic codes or for other repair, the "learning" process resets and begins again. A change may be noted in the vehicle's performance. To "teach" the vehicle, ensure that the engine is at operating temperature. The vehicle should be driven at part throttle, with moderate acceleration and idle conditions until normal performance returns.

All diagnostic procedures must always begin with the "DIAGNOSTIC CIRCUIT CHECK."

Diagnostic procedures must begin with the "Diagnostic Circuit Check," which represents an organized approach for identifying system problems.

The "DIAGNOSTIC CIRCUIT CHECK" makes an initial check of the system, and then will direct the mechanic to other charts in the book. It must be used as a starting point for all procedures. The entire book is set up in a specific order, that is, the "DIAGNOSTIC CIRCUIT CHECK" will lead the mechanic to other charts, and those charts may lead to still other charts. **THE SEQUENCE MUST BE FOLLOWED.** The engine control system uses many input signals and controls many output functions. If the correct diagnostic sequence is not followed, incorrect diagnosis and replacement of good parts may happen.

Diagnostic charts incorporate diagnosis procedures using a Tech 1 "Scan" tool where possible. This Tech 1 "Scan" tool is a small hand-held computer in itself. Its job is to give information to a mechanic about what is happening in the engine management system.

The assembly line data link connector is used by the assembly plant to perform end of line tests. This connector can also be used by mechanics to monitor certain inputs and outputs as seen by the electronic control module. The Tech 1 "Scan" tool reads and displays the information (serial data) supplied to the assembly line data link connector from the electronic control module.

DIAGNOSIS PROCEDURE

In response to the "Check Engine" light or an owner complaint relating to engine performance,

ALL FAULT FINDING SHOULD FOLLOW THE DIAGNOSIS CHARTS,

BEGINNING WITH THE

DIAGNOSTIC CIRCUIT CHECK!

DIAGNOSTIC CIRCUIT CHECK

After the visual/physical underhood inspection, the "Diagnostic Circuit Check" in Section "2.9A" is the starting point for all diagnostic procedures or finding the cause of an emissions test failure.

The correct procedure to diagnose a problem is to follow three basic steps.

1. **Are the on-vehicle diagnostics working?** This is determined by performing the "Diagnostic Circuit Check." Since this is the starting point for the diagnostic procedures or finding the cause of an emissions test failure, *always begin here.*

   If the on-vehicle diagnostics aren't working, the "Diagnostic Circuit Check" will lead to a diagnostic chart. If the on-vehicle diagnostics are working correctly, the next step is:

2. **Is there a code stored?** If a code is stored, go directly to the numbered code chart. This will determine if the fault is still present. If no code is stored, then:

3. **Observe Serial Data information transmitted by the electronic control module.** This involves reading the information available on the assembly line data link/Serial Data Stream with a Tech 1 "Scan" tool. Information on this tool and the meaning of the various displays can be found in the succeeding paragraphs. Typical data readings under a particular operating condition can be found in: Section "2.9A", "Diagnostic Charts" - Tech 1 "Scan" Tool Typical Data Values.

2.3 TECH 1 "SCAN" TOOL DESCRIPTION

TECH 1 "SCAN" TOOL

The electronic control module can communicate a variety of information through assembly line data link connector terminal "M". This data is transmitted at a high frequency which requires a Tech 1 "Scan" tool for interpretation.

TECH 1 "SCAN" TOOL EXPLANATION

To explain how the "Scan" tool works, let's think for a minute about how a television works. A television is an electronic device that receives and processes information, and sends out information in a form that can be understood by the person watching it. The television receives a signal (from a transmitting station) that is not usable to the person. The television processes it, then sends the signal to a screen. The person can then see the information that the television transmitting station sent out. The "Scan" tool is like the television because it also processes information, sent to it by the electronic control module. The information is sent out of the electronic control module to the assembly line data link connector terminal "M". The "Scan" tool plugs into the assembly line data link connector, and the information is sent to the tool on its cable. The "Scan" tool processes the information, and "sends" the signal to a display screen on the tool. Just like a television, you can select which "station" that you want to see. The difference is instead of seeing the picture on a television, you "see" the display screen, and the "stations" that you can select on a "Scan" tool are the different input and output signals that are being processed by the electronic control module.

TECH 1 "SCAN" TOOL USES

The "Scan" tool is a useful and quick way of comparing operating parameters of a poorly operating engine with a known good one. For example, a sensor may shift its value but not set a code. Comparison with a known good vehicle may uncover this problem.

The "Scan" tool allows a quick check of sensors and switches which are inputs to the electronic control module. The electronic control module in the vehicle sends out information to the "Scan" tool at a very fast rate, and the display on the tool can update quicker than a digital voltmeter. The "Scan" tool allows a mechani · to manipulate wiring harnesses or components under the hood while observing the "Scan" readout. This can help in locating intermittent connections.

TECH 1 "SCAN" TOOL USE WITH INTERMITTENTS

The Tech 1 "Scan" tool allows manipulation of wiring harnesses or components under the hood with the engine not running, while observing the Tech 1 "Scan" tool readout.

The Tech 1 "Scan" tool can be plugged in and observed while driving the vehicle under the condition when the "Check Engine" light turns "ON" momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the Tech 1 "Scan" tool, they should be checked while driving the vehicle. If there does not seem to be any connection between the problem and any specific circuit, the Tech 1 "Scan" tool can be used to monitor each parameter, watching for a period of time to see if there is any change in the readings that indicates intermittent operation.

The Tech 1 "Scan" tool can capture and store data when the problem occurs, so it can be played back at a slower rate to determine what happened to the system. This is called the "SNAPSHOT" mode.

The Tech 1 "Scan" tool is an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a diagnostic code. Comparing the sensor's readings with those of a known good vehicle may uncover the problem.

The Tech 1 "Scan" tool saves time in diagnosis and helps to prevent the replacement of good parts. The key to using the Tech 1 "Scan" tool successfully is the technician's ability to understand the system being diagnosed, as well as understanding the Tech 1 "Scan" tool operation and limitations. The technician should read the Tech 1 operating manual to become familiar with the Tech 1 operation.

ADDITIONAL TECH 1 FUNCTIONS:

"SNAPSHOT"

The Tech 1 tool has the ability to capture and store data parameters as they occur. This data can then be replayed and studied to help you locate current and intermittent problems.

"MISCELLANEOUS TESTS"

The Tech 1 "Scan" tool also has the ability to send signals to the electronic control module, instructing the electronic control module to perform various functions or tasks.

This provides a quick way to determine if a device is operational or not. Also included is a command to erase all stored diagnostic trouble codes from the electronic control module's memory.

Briefly stated, one of the Tech 1 menu selections is called "MISCELLANEOUS TESTS." After making that selection, other menu selections can be chosen. Each one is described below.

OUTPUT TESTS

- **Intake manifold heater relay** "ON" and "OFF" control. Recommend to observe "SYSTEM VOLTAGE" while commanding the manifold heater to cycle "ON" and "OFF." System voltage should decrease slightly when the manifold heater is "ON," due to large current draw.
- **Air conditioning compressor clutch control relay** "ON" and "OFF" command can be initiated. Listen for the compressor clutch engagement with the engine at idle and air conditioning controls in the "ON" position.
- **"Check Engine" lamp** "ON" and "OFF" control.
- **Evaporative Emissions storage canister solenoid** "ON" and "OFF" control. Recommended to operate engine until fully warm, then observe "CLOSED LOOP FUEL ADJUSTMENT" as "EVAP SOLENOID" is cycled "ON" and "OFF." Percentage of fuel adjustment (XX%) should quickly change as canister is purged of fuel vapors.

IDLE SYSTEM

- **Idle control:** To exercise the idle air control motor, by changing the "desired idle speed" up or down. The idle air control valve should track this command, and engine speed should follow up or down if the idle air control valve is functioning properly.
- **Idle reset:** To reset the idle air control valve. Should cause the idle air control valve to fully extend to the zero (0) step, fully shut position, then retract to a known position.

OCTANE ADJUST

- This function instructs the electronic control module to "read, store, and use" the current value of the octane adjustment potentiometer input signal. This adjustment is usually set at the factory to allow using high octane fuel. An adjustment would be performed if the customer desires to use low octane fuel. When the Tech 1 is not commanding this function, the octane adjustment input signal from the potentiometer is only used to determine if the circuit is good or faulty. Refer to CHART C-15, "Octane Adjustment," for further information.

CLEAR CODES

- This function will erase all stored diagnostic trouble codes from the electronic control module's memory, without the need to either disconnect the battery or remove power from the electronic control module.

CRANK TEST

- This is a special test that monitors and records the engine cranking speed (revolutions per minute), battery voltage while cranking, and could be useful in diagnosing a "hard start" engine that might be due to low engine cranking speed.

TECH 1 "SCAN" TOOL LIMITATIONS

The Tech 1 "Scan" tool must receive the signal from the electronic control module in order to display any usable information. If the electronic control module sends no signals to the assembly line data link diagnostic connector, or the connection to the Tech 1 is defective, the Tech 1 "Scan" tool will only display, **"NO DATA. RESELECT OR TURN "OFF" AND CHECK ASSEMBLY LINE DATA LINK CONNECTOR."** The "DIAGNOSTIC CIRCUIT CHECK" instructs the mechanic what to do if this happens.

The Tech 1 "Scan" tool has a few limitations. If the Tech 1 "Scan" tool is displaying an electronic control module "output" function, it displays only the *command* given by the electronic control module. That does not mean that the desired action took place. This is similar to the dashboard gearshift indicator on a vehicle with an automatic transmission. Just because the gearshift pointer indicates the transmission is in "drive" gear does not mean that the transmission is actually in that gear. To be sure, you must check the linkage and adjustment at the transmission. When using the Tech 1 "Scan" tool to observe one of the electronic control module "output" functions, such as intake manifold heater, idle air control valve, or canister purge, the mechanic must not assume the *indicated* is the same as the *actual*. If the Tech 1 "Scan" tool is displaying manifold heater as being "ON," but the manifold heater relay is disconnected or defective, or if the heater element is burnt out, the electronic control module has no way of knowing it. The display may indicate the command is "ON," but the device may not be operating!

The Tech 1 "Scan" tool saves time in diagnosis and helps to prevent the replacement of good parts. *The key to using the "Scan" tool successfully for diagnosis is the technician's ability to understand the system being diagnosed, as well as an understanding of the Tech 1 "Scan" tool's limitations.*

The following information will describe all of the Tech 1 "Scan" tool mode F0 data list displays, and how they help in diagnosis.

With an understanding of the data the Tech 1 "Scan" tool displays, and knowledge of the circuits involved, the Tech 1 "Scan" tool is useful in getting information which is difficult or impossible to get with other methods.

The Tech I "Scan" tool does NOT make using diagnostic charts unnecessary, nor can it tell you exactly where a problem is in a circuit. Most diagnostic charts incorporate diagnosis procedures that require the use of a Tech 1 "Scan" tool.

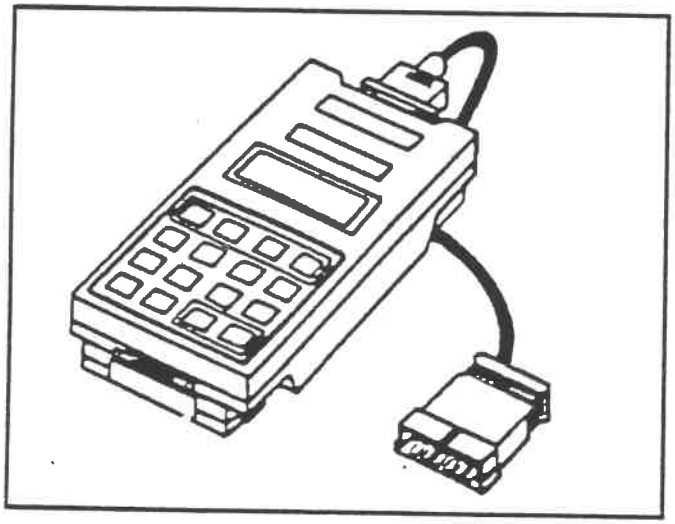


Figure 2.3-1 Tech 1 "Scan" Tool

DIAGNOSTIC MODES

The electronic control module and the Tech 1 tool have various modes for communicating information between themselves. The following describes system operation in the different modes.

DIAGNOSTIC DISPLAY MODE

1. Ignition "ON," engine not running.
2. Tech 1 in the "F1: Field Service" mode, but with the *engine not running*. (This can also be done without the Tech 1 by using a jumper wire to connect the assembly line data link connector terminals "A" and "B" together.)

When in the diagnostic display mode, these actions take place:

- "Check Engine" light flashes codes.
- Certain solenoids and relays are energized.
- Idle air control valve moves to its fully extended position, closing the idle air passage in the throttle body injection unit.
- Diagnostic trouble codes cannot be stored.

FIELD SERVICE MODE

Similar to "Diagnostic Display" mode, except with the *engine running*.

1. Engine running.
2. Tech 1 in the "F1: Field Service" mode. (This can also be done without the Tech 1 by using a jumper wire to connect the assembly line data link connector terminals "A" and "B" together.)

When in the "Field Service" mode, these actions take place:

- Electronic spark timing will be fixed at 10° before top dead center when engine revolutions per minute are less than 2,000.
- Idle air control valve will be commanded to a fixed position.
- In the "Field Service" mode, the "Check Engine" light will flash in a different manner. Refer to "Field Service" mode explanation on Page 2-6 for information about how the "Check Engine" light will flash in this mode.

TECH 1 " F0: DATA LIST" PARAMETERS

TECH 1 "F0: DATA LIST"

When the Tech 1 tool is connected and the F0 data list mode is selected, the data parameters are displayed in pairs.

The Tech 1 has preprogrammed data pairs. If custom data pairs are desired, any individual parameter can be paired with any other parameter. Refer to the Tech 1 owner's manual for further information about selecting customized data parameter pairs.

ENGINE SPEED

Displays the electronic control module's interpretation of actual engine revolutions per minute, as received from the crankshaft reference input signal.

Often useful to detect if extra reference pulses are suspected. A sudden high engine speed indication while at a steady throttle would indicate electrical interference in the crankshaft reference input signal circuit. This interference is usually caused by electronic control module wires too close to ignition secondary wires or an open crankshaft reference low Circuit 58 wire.

DESIRED IDLE

While the engine is idling the electronic control module is controlling idle speed. Desired idle is the closed throttle engine speed that is commanded by the electronic control module.

COOLANT TEMPERATURE

Displays the electronic control module's interpretation of coolant temperature in the engine. The coolant temperature sensor is mounted in the engine and is wired to the electronic control module. The electronic control module monitors the difference in voltage between two terminals, and then converts the voltage to a temperature shown in degrees Celsius. The reading should read close to the air temperature when the engine is cold, and rise as the coolant temperature rises. After engine is started the temperature should rise steadily to about 85°C-95°C then stabilize as the thermostat opens.

INTAKE AIR TEMPERATURE

Displays intake air temperature as interpreted by the electronic control module. The intake air temperature sensor is a thermistor and is mounted in the air cleaner.

THROTTLE POSITION

Displays the throttle position sensor signal input to the electronic control module. Values will be in voltage from which the electronic control module calculates the throttle opening.

The display is the electronic control module's interpretation of the throttle position sensor input voltage. With the throttle fully closed the voltage should be within 0.25–1.25 volts and go up to about 4.5 volts at wide open throttle.

THROTTLE ANGLE

Displays the electronic control module computed throttle angle as a function of the throttle position sensor input voltage (see above). 0% refers to a completely closed throttle while 100% is wide open.

MANIFOLD ABSOLUTE PRESSURE

Displays the electronic control module's interpretation of the intake manifold absolute pressure. Manifold absolute pressure sensor output voltage range is from zero to five volts, but the normal operating range is from about 0.30 to 4.90 volts. This value on the Tech 1 "Scan" tool cannot change until the engine is started, even though the actual manifold absolute pressure sensor output voltage can change. With the engine running, the voltage will be about 1–2 volts at idle. As engine load increases, this voltage also increases.

BAROMETRIC PRESSURE

This parameter represents calculated barometric air pressure, based on the signal from the absolute pressure sensor when the ignition is first switched "ON" before the engine starts. The electronic control module can update its baro pressure calculation when the engine is operating with the throttle nearly wide open at low engine speed. Because barometric air pressure depends on altitude, it may vary from 105 kPa (at or below sea level) to 60 kPa (4300 meters above sea level). On the Tech 1, the calculated barometric pressure is displayed.

OXYGEN SENSOR VOLTAGE

Displays oxygen sensor voltage in millivolts. When the sensor is cold this voltage will be close to 450 mV. As the sensor's electric heater begins to heat up the oxygen sensor, the voltage will fluctuate between 100–900 mV when the engine is running. If the engine isn't running but the ignition is "ON," the oxygen sensor voltage will slowly decrease to less than 200 mV.

EXHAUST GASES (RICH/LEAN)

This display will indicate if the electronic control module is interpreting a "rich" or "lean" exhaust signal from the oxygen sensor.

OXYGEN SENSOR READY (YES/NO)

This display will indicate whether or not the oxygen sensor is in the "ready" state. "Ready" can also be interpreted as "up to temperature."

"OPEN/CLOSED LOOP" FUEL CONTROL

Displays either "Open Loop" or "Closed Loop" depending on the state of the fuel control system. Time since start up, oxygen sensor ready status and coolant temperature all contribute to the change from "Open" to "Closed Loop."

"CLOSED LOOP" FUEL ADJUSTMENT

This will display corrections made to the fuel injector pulse width based on the rich/lean indication from the oxygen sensor signal. As with memory fuel adjustment, the scale will be -99% to + 99%.

MEMORY FUEL ADJUSTMENT

Indicates what "state" the fuel correction is in. 0% is the middle with no fuel being reduced from or added to the injector pulse width calculations. If fuel is being added to the system the display will read between +1% and +99%. If fuel is being reduced the display will read between -1% and -99%.

MEMORY FUEL ADJUSTMENT CELL

This display will indicate which memory fuel cell is currently being used.

AIR FUEL RATIO

The amount of air compared to the amount of fuel in the air-fuel mixture commanded by the electronic control module. See "Stoichiometric Ratio" in glossary.

POWER ENRICHMENT MODE ACTIVE? (YES/NO)

The display will indicate whether or not the fuel control system is in the power enrichment mode.

DECEL FUEL CUT MODE IN EFFECT? (YES/NO)

Display indicates when decel fuel cut off mode is in effect.

EVAPORATIVE EMISSION CANISTER PURGE CYCLE

Displays the pulse width modulation command (0–100%) of the canister purge solenoid.

FUEL INJECTOR PULSE WIDTH

The injector pulse width is the length of time (in milliseconds) the electronic control module is commanding the fuel injector on. Injector "ON" time is how electronic fuel injection systems control fuel mixture (air/fuel ratio). A longer "ON" time yields more fuel delivered, and a richer mixture.

SPARK ADVANCE

Displays the final total spark advance delivered to the spark plug.

OCTANE ADJUST

This will display the voltage that the electronic control module is interpreting from the octane adjust potentiometer. This also displays the value of ignition timing retard as it relates to the voltage mentioned above.

IDLE AIR CONTROL POSITION (0-255)

Displays the numbers that indicate what position the electronic control module has commanded the idle air control valve to be at. The electronic control module moves the idle air control in steps and these steps are what is displayed on the Tech 1 "Scan" tool. The number of "steps" or "counts" indicate how far open or shut the idle air passageway in the throttle body is. Larger numbers mean a larger opening in the idle air passageway, and a higher idle speed should occur. After the engine starts, the numbers should decrease as the engine warms to normal operating temperature. With the engine idling in "neutral" and the air conditioning not "ON," the numbers should be between 5 and 50 steps. Anything that makes the engine work harder at idle will cause this number to increase. Remember, this position shows the electronic control module *command*. There is no way to verify that the actual idle air control position is equal to the command.

VEHICLE SPEED

Displays the electronic control module's interpretation of vehicle speed, as received from the vehicle speed sensor. If this position indicates no vehicle speed (zero), but the speedometer shows otherwise, then a Code 24 will eventually set. Also useful in checking speedometer accuracy.

RADIATOR FAN

This will display "NOT USED" on NIVA vehicles.

INTAKE MANIFOLD HEATER ("ON/OFF") RELAY

This will display the ("ON/OFF") status of the electronic control module control of this output.

SYSTEM VOLTAGE

This will display the voltage of the battery, as interpreted by the electronic control module from the terminal which is connected to "Switched + 12V" from the ignition switch.

AIR CONDITIONING REQUEST (YES/NO)

Displays when the operator has requested air conditioning The display is the electronic control module's interpretation of the air conditioning request input signal to the electronic control module. The display will show "YES" if the electronic control module has 12 volts on this terminal, indicating that the electronic control module has been requested to turn "ON" the air conditioning compressor clutch. The display will show "NO" if the request signal is not received. The signal is a 12 volt signal from the air conditioning control switches.

Before the signal is received at the electronic control module, it must pass through the air conditioning high-side high-pressure switch, and the air conditioning cycling switch. If the switches are open the Tech 1 will display "NO" even though the air conditioning request switch is closed.

AIR CONDITIONING ("ON/OFF") CLUTCH

The display will show the electronic control module's command to the air conditioning compressor control relay. It will show "ON" if the electronic control module has commanded the relay to operate the compressor, and "OFF" if the electronic control module has not commanded the relay to operate the compressor. Remember that the electronic control module command to the control relay is just that, a command. Do not assume that the compressor is running just because the command says "ON."

FUEL PUMP CIRCUIT ("ON/OFF")

Indicates whether or not the fuel pump circuit is energized. This is a valuable display when diagnosing a suspected fuel pump circuit failure.

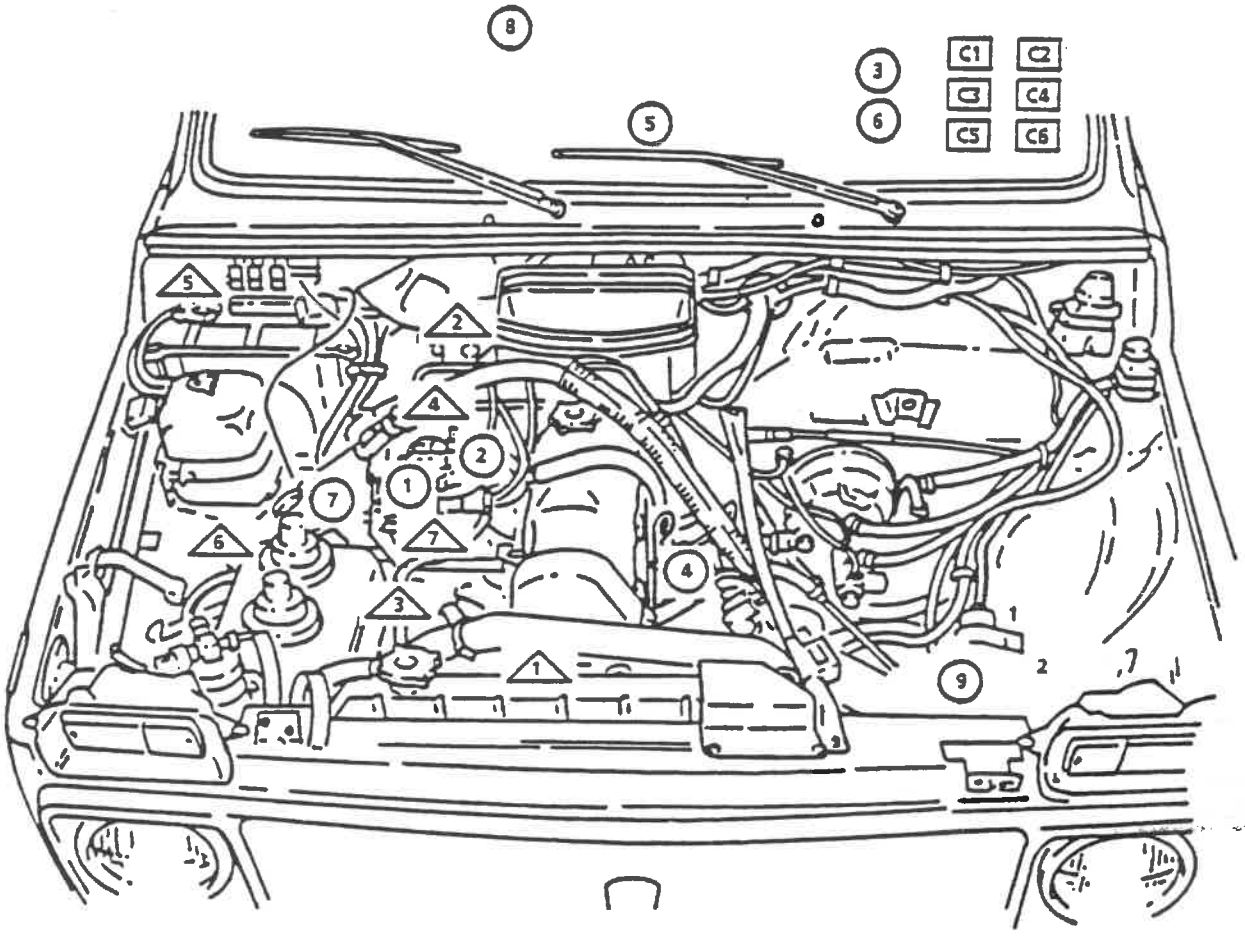
CALIBRATION IDENTIFICATION

The programmable read only memory is located inside the electronic control module and has information on the vehicle's weight, engine transmission, axle ratio and other items specific to each vehicle. This identification is used to determine if the engine calibrator is the correct one for a particular vehicle.

TIME FROM START

Time from start is available and is a measure of how long the engine has been running. If the engine stops, time from start will reset to 0:00:00.

2.4 UNDERHOOD LOCATION VIEW 1.7L THROTTLE BODY INJECTION



□ COMPUTER HARNESS

- C1 Electronic Control Module
- C2 Assembly Line Data Link*
- C3 Fuse/Relay Block*
- C4 Cross Car Harness Connector*
- C5 Fuel Pump to Electronic Control Module Connector*
- C6 Maxi-Fuse*

MISCELLANEOUS

1. Fuel Filter
2. Fuel Pressure Tap*

○ CONTROLLED DEVICES

1. Fuel Injector
2. Idle Air Control Valve
3. Fuel Pump Relay*
4. Ignition System Coils
5. Check Engine Light
6. Intake Manifold Heater Relay
7. Intake Manifold Heater (Under Throttle Body Injection Unit)
8. Fuel Pump (Under Access Panel in Storage Area)
9. Evaporative Emission Canister (mounted inside of the Engine Compartment near the radiator)

△ INFORMATION SENSORS

1. Crankshaft Position Sensor (Front of Engine, near end of Crankshaft)
2. Manifold Absolute Pressure Sensor
3. Coolant Temperature Sensor
4. Throttle Position Sensor
5. Octane Adjust Potentiometer
6. Oxygen Sensor (mounted in Exhaust Manifold below Throttle Body Injection Unit)
7. Intake Air Temperature Sensor (mounted in Air Cleaner - not shown)
8. Vehicle Speed Sensor (mounted under Vehicle to Transmission - not shown)

* Actual location may vary.

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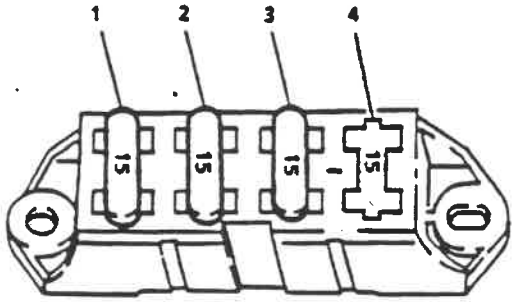
2.5 FUSEBLOCK VIEWS



COLORS ARE SHOWN ON UNDERSIDE OF FUSE HOLDER

FUSE IDENTIFICATION CHART

NUMBER	COLOR
1	RED
2	BLACK
3	GREEN
4	YELLOW

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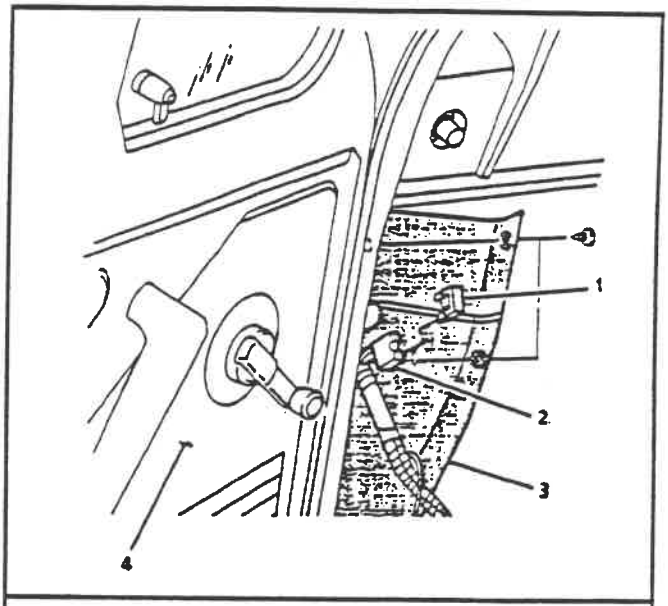


1 MAXI-FUSE

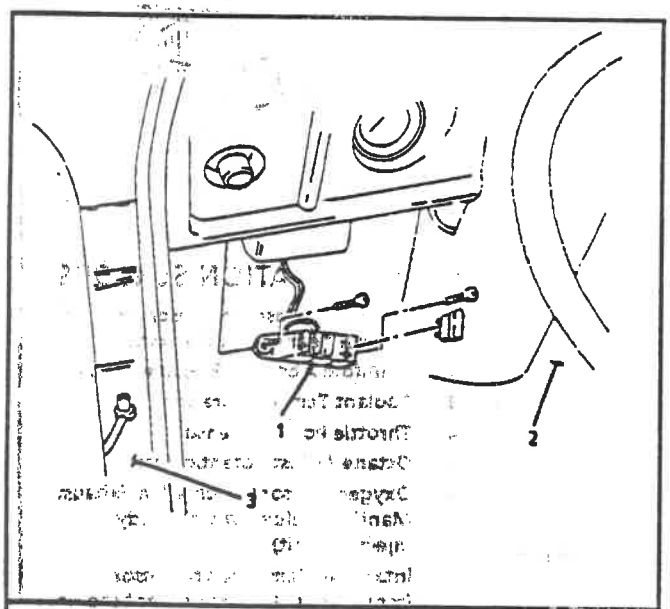
2 MAXI-FUSE CONNECTOR

3 KICK PANEL

4 DRIVER'S DOOR

NS 13193

Maxi-Fuse Location View



1 FUSEBLOCK

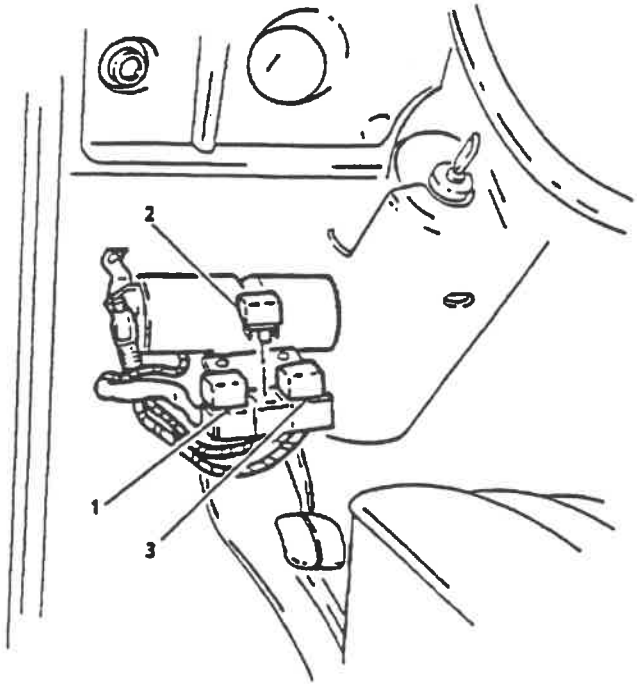
2 STEERING WHEEL

3 DRIVER SIDE DOOR

NS 13184

Fuse Block Location View

2.6 RELAY CALLOUT AND LOCATION VIEW

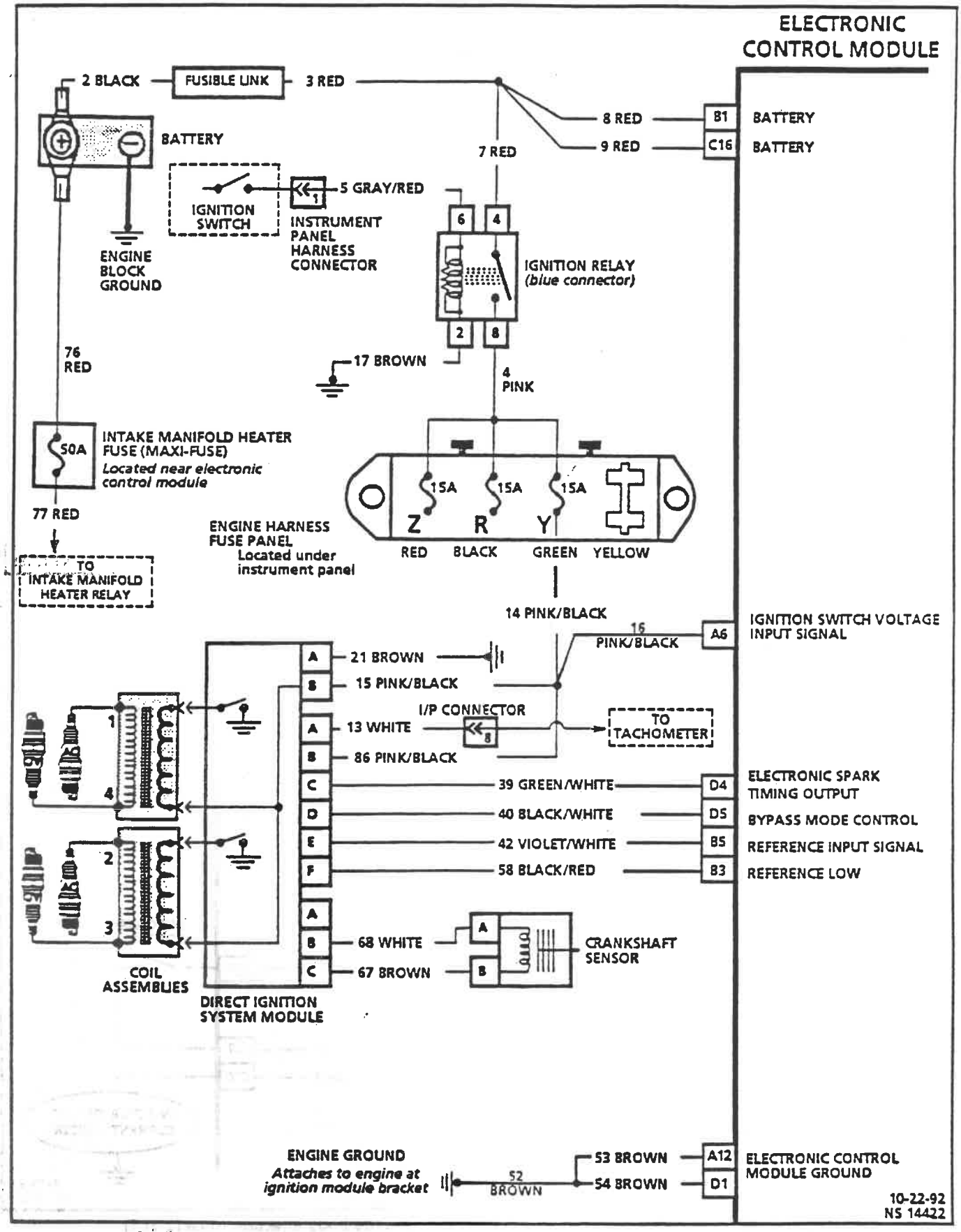


1 FUEL PUMP RELAY (RED)

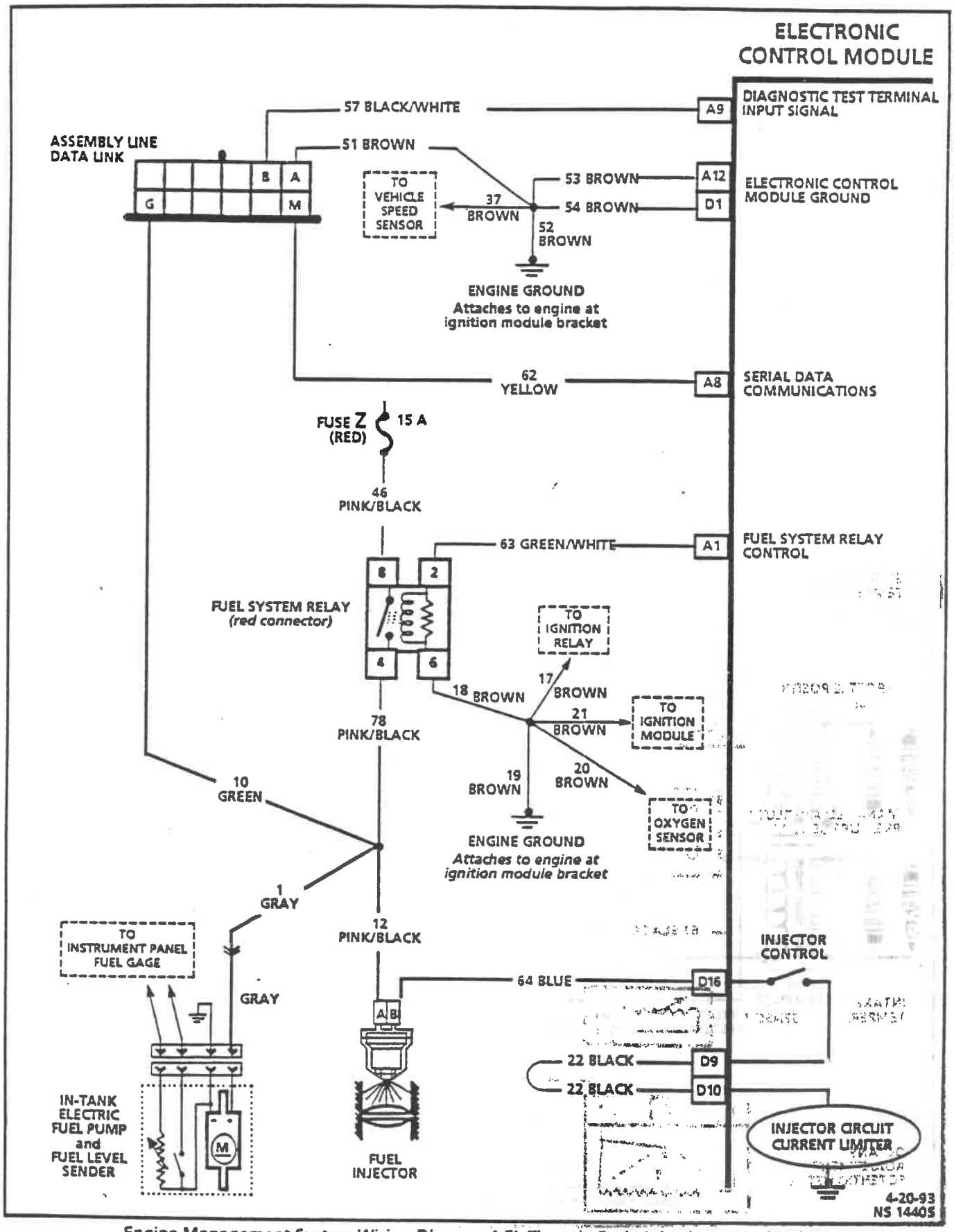
2 INTAKE MANIFOLD HEATER RELAY (BLACK)

3 IGNITION RELAY (BLUE)

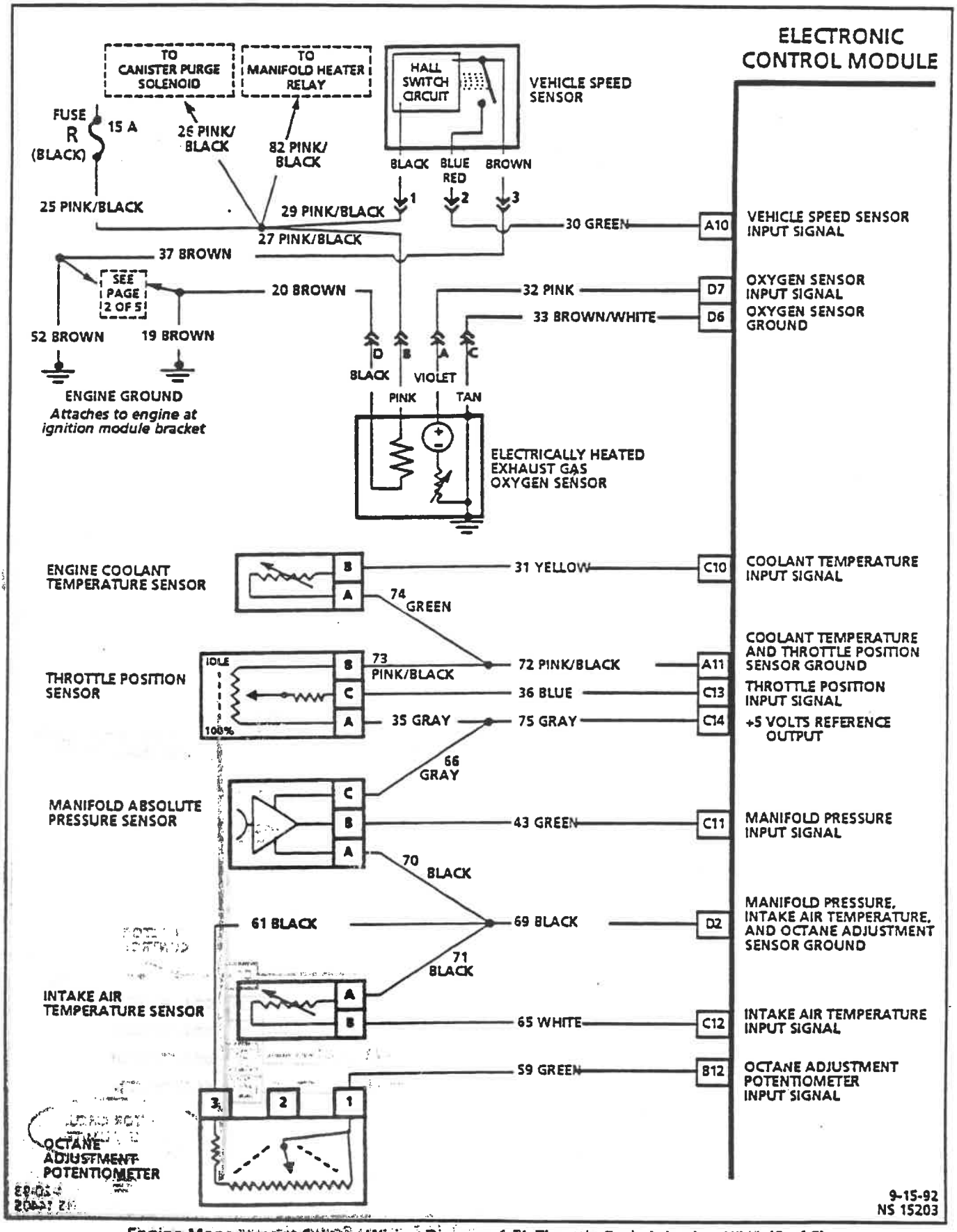
NS 13185



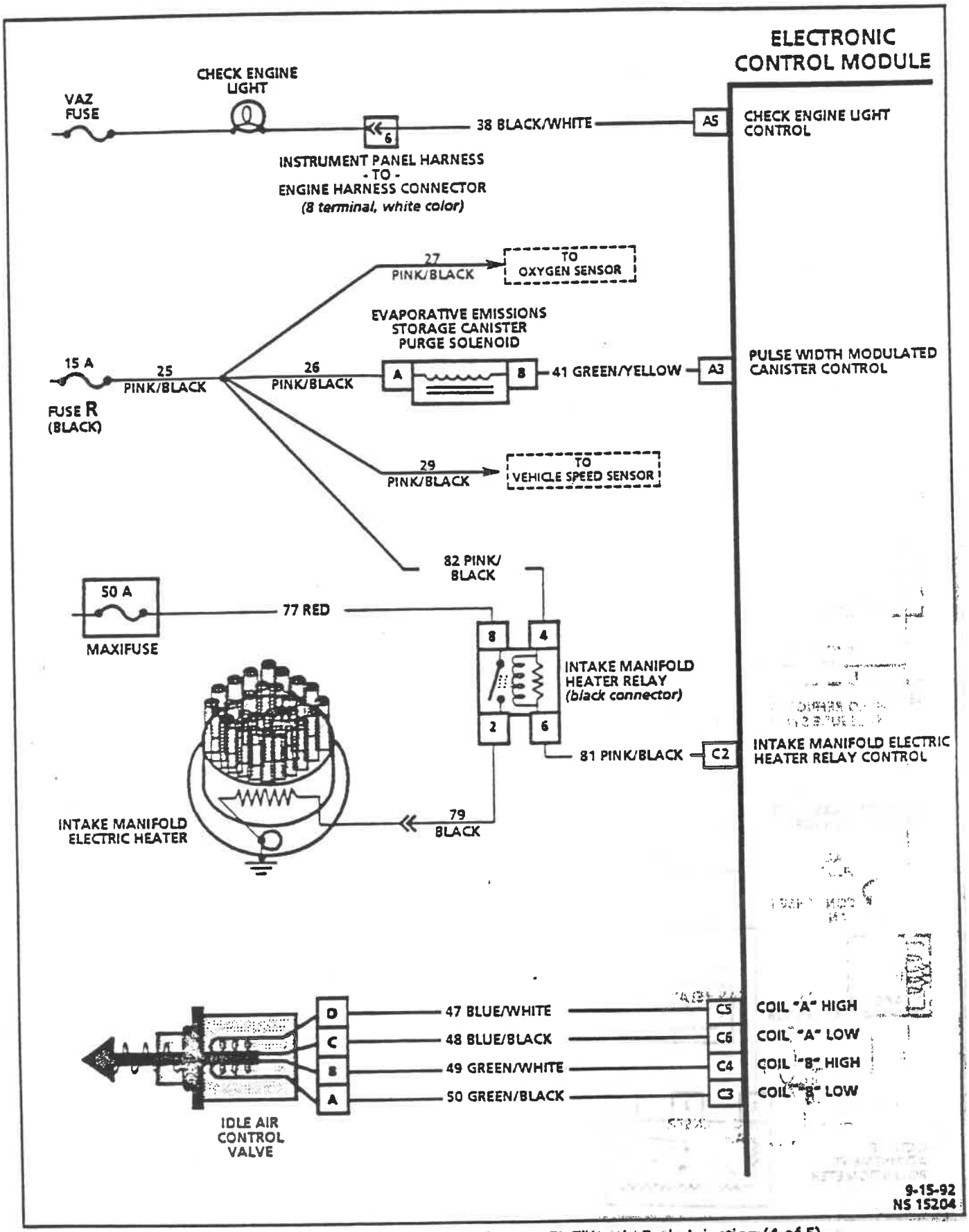
Engine Management System Wiring Diagram 1.7L Throttle Body Injection NIVA (1 of 5)



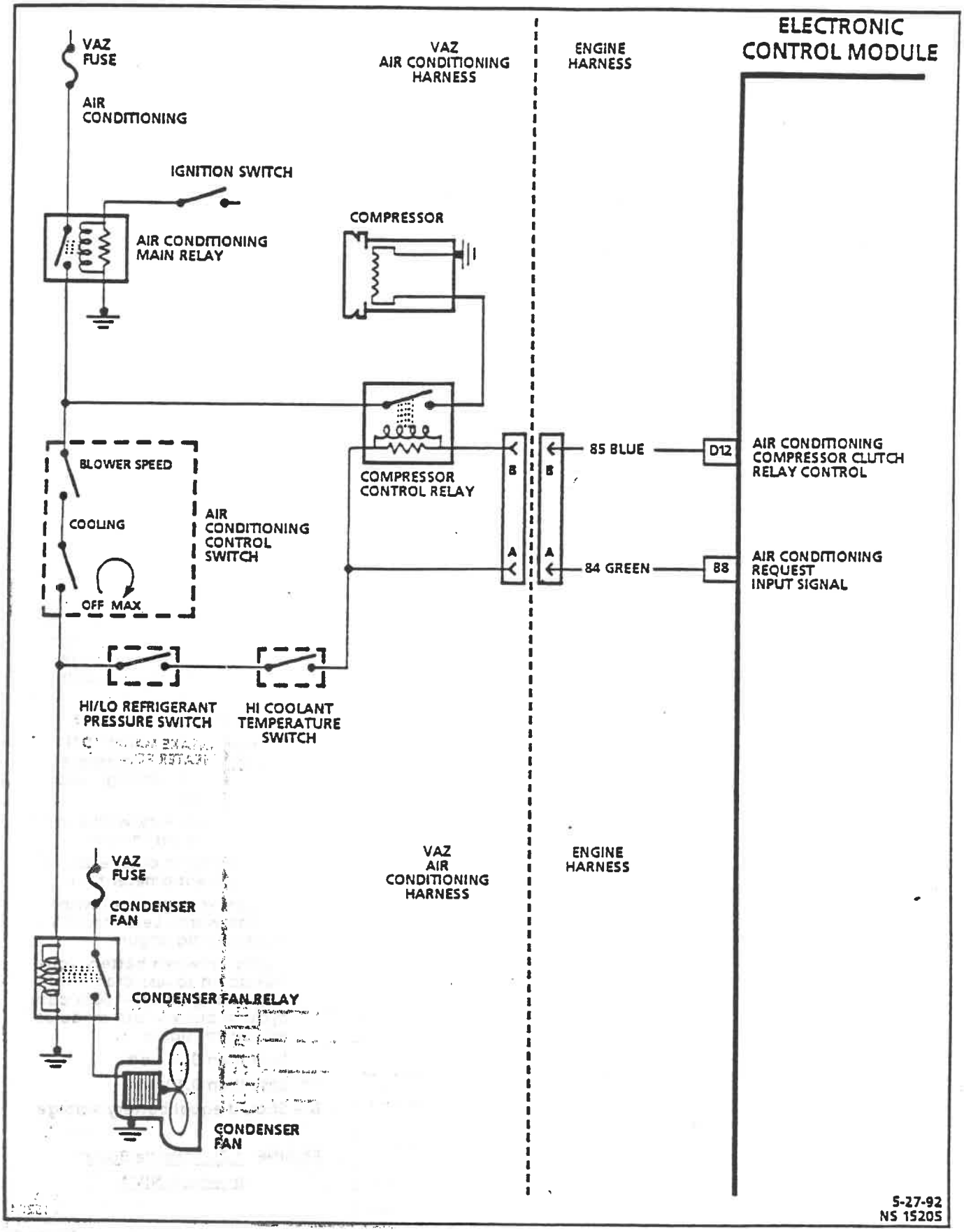
Engine Management System Wiring Diagram 1.7L Throttle Body Injection NIVA (2 of 5)



Engine Management System Wiring Diagram 1.7L Throttle Body Injection NIVA (3 of 5)



Engine Management System Wiring Diagram 1.7L Throttle Body Injection (4 of 5)



Engine Management System Wiring Diagram 1.7L Throttle Body Injection NIVA (5 of 5)

2.7 ELECTRONIC CONTROL MODULE CONNECTOR IDENTIFICATION CHARTS

TBI ELECTRONIC CONTROL MODULE CONNECTOR IDENTIFICATION

This electronic control module voltage chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING

- Engine at operating temperature
- Engine idling (For "Engine Run" column)
- Diagnostic "test" terminal not grounded
- Tech 1 "Scan" tool not installed
- Air conditioning "OFF"
- Digital voltmeter "—" (negative) lead connected to a good clean ground point.

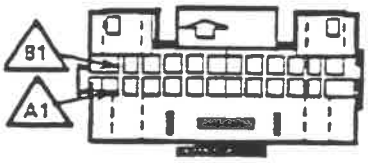
DC VOLTAGE

	IGN "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR
①	0**	B+	FUEL SYSTEM RELAY CONTROL	A1	GREEN/ WHITE
			NO CONNECTION	A2	
	B+	VARIES ⑧	PULSE WIDTH MODULATED CANISTER CONTROL	A3	GREEN/ YELLOW
			NO CONNECTION	A4	
	0*	B+	CHECK ENGINE LIGHT CONTROL	A5	BLACK/ WHITE
	B+	B+	IGNITION SWITCH VOLTAGE INPUT SIGNAL	A6	PINK/ BLACK
			NO CONNECTION	A7	
	2–5 VARYING	2–5 VARYING	SERIAL DATA COMMUNICATIONS	A8	ORANGE
	5	5	DIAGNOSTIC "TEST" TERMINAL INPUT SIGNAL	A9	BLACK/ WHITE
②	VARIES	VARIES	VEHICLE SPEED INPUT SIGNAL	A10	GREEN
	0**	0**	COOLANT TEMPERATURE SENSOR & THROTTLE POSITION SENSOR GROUND	A11	PINK/ BLACK
	0**	0**	ELECTRONIC CONTROL MODULE GROUND	A12	BROWN

DC VOLTAGE

	IGN "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR
	B+	B+	BATTERY + (POWER SUPPLY)	B1	RED
			NO CONNECTION	B2	
	0**	0**	CRANKSHAFT REFERENCE LOW	B3	BLACK/ RED
			NO CONNECTION	B4	
	0*	⑤	CRANKSHAFT REFERENCE INPUT SIGNAL	B5	PURPLE/ WHITE
			NO CONNECTION	B6	
			NO CONNECTION	B7	
"OFF" "ON"	0* 0*	0* B+	AIR CONDITIONING REQUEST INPUT SIGNAL	B8	GREEN
			NO CONNECTION	B9	
			NO CONNECTION	B10	
			NO CONNECTION	B11	
⑤	1–5 VOLT	1–5 VOLT	OCTANE ADJUSTMENT INPUT SIGNAL	B12	GREEN

24-PIN A-B CONNECTOR



BACK VIEW OF CONNECTOR

1 Battery voltage for first two seconds, after ignition is turned "ON" without cranking the engine.

2 When vehicle is stopped, voltage will be either less than 1 volt or more than 10 volts; depending upon position of drive wheels. When vehicle is moving, voltage will vary depending upon vehicle speed.

3 Varies with temperature.

4 Varies. With ignition "ON," reads barometric pressure. With engine running, reads engine load.

5 Voltage will vary with engine revolutions per minute.

6 Depending on octane adjustment potentiometer trim.

7 Battery voltage (B+) with engine warm. Less than 0.5 volts on cold engine.

8 Varies between battery voltage down to less than 1 volt, depending on 0%–100% duty cycle of pulse width modulated control signal.

* Less than 0,50 volt.

** Less than 0,10 volt.

B+ Should equal battery voltage

ENGINE 1.7L Throttle Body Injection/NIVA

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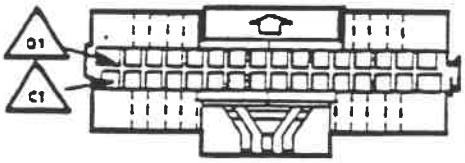
Figure 2.7-1 ECM Connector Terminal End View 1.7L Throttle Body Injection NIVA (1 of 2)

DC VOLTAGE

IGN "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR
		NO CONNECTION	C1	
B+	B+	INTAKE MANIFOLD ELECTRIC HEATER RELAY CONTROL	C2	PINK/ BLACK
NOT	USEABLE	IDLE AIR CONTROL COIL "B" LOW	C3	GREEN BLACK
NOT	USEABLE	IDLE AIR CONTROL COIL "B" HIGH	C4	GREEN/ WHITE
NOT	USEABLE	IDLE AIR CONTROL COIL "A" LOW	C5	BLUE/ BLACK
NOT	USEABLE	IDLE AIR CONTROL COIL "A" HIGH	C6	BLUE/ WHITE
		NO CONNECTION	C7	
		NO CONNECTION	C8	
		NO CONNECTION	C9	
③ 1–2	1–2	COOLANT TEMPERATURE INPUT SIGNAL	C10	YELLOW
④ 3.5 – 5.0	0.9 – 1.5	MANIFOLD ABSOLUTE PRESSURE INPUT SIGNAL	C11	GREEN
③		INTAKE AIR TEMPERATURE INPUT SIGNAL	C12	WHITE
.3 – .7	.3 – .7	THROTTLE POSITION INPUT SIGNAL	C13	BLUE
5	5	+5 VOLT REFERENCE OUTPUT	C14	GRAY
		NO CONNECTION	C15	
B+	B+	BATTERY +	C16	RED

32-PIN C-D CONNECTOR



BACK VIEW OF CONNECTOR

DC VOLTAGE

IGN "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR
0**	0**	ELECTRONIC CONTROL MODULE GROUND	D1	BROWN
0**	0**	OCTANE ADJUST POTENTIOMETER, MANIFOLD ABSOLUTE PRESSURE SENSOR, AND INTAKE AIR TEMPERATURE SENSOR GROUND	D2	BLACK
		NO CONNECTION	D3	
0*	1,2	ELECTRONIC SPARK TIMING OUTPUT	D4	GREEN/ WHITE
0	4,6	IGNITION MODULE BYPASS MODE CONTROL	D5	BLACK/ WHITE
0**	0*	OXYGEN SENSOR GROUND	D6	BROWN
0.1–0.2	VARIES	OXYGEN SENSOR INPUT SIGNAL	D7	PINK
		NO CONNECTION	D8	
0**	0**	INJECTOR CIRCUIT CURRENT LIMITER JUMPER	D9	BLACK
0**	0**	INJECTOR CIRCUIT CURRENT LIMITER JUMPER	D10	BLACK
		NO CONNECTION	D11	
0*	B+ A/C "OFF" 0* A/C "ON"	AIR CONDITIONING COMPRESSOR CLUTCH RELAY CONTROL	D12	BLUE
		NO CONNECTION	D13	
		NO CONNECTION	D14	
		NO CONNECTION	D15	
B+	B+	INJECTOR CONTROL	D16	BLUE

1 Battery voltage for first two seconds, after ignition is turned "ON" without cranking the engine.

2 When vehicle is stopped, voltage will be either less than 1 volt or more than 10 volts; depending upon position of drive wheels. When vehicle is moving, voltage will vary depending upon vehicle speed.

3 Varies with temperature.

4 Varies. With ignition "ON," reads barometric pressure. With engine running, reads engine load.

5 Voltage will vary with engine revolutions per minute.

6 Depending on octane adjustment potentiometer trim.

7 Battery voltage (B +) with engine warm. Less than 0.5 volts on cold engine.

8 Varies between battery voltage down to less than 1 volt, depending on 0%–100% duty cycle of pulse width modulated control signal.

* Less than 0.50 volt.

** Less than 0.10 volt.

B + Should equal battery voltage

ENGINE 1.7L Throttle Body Injection/NIVA

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Figure 2.7-2 ECM Connector Terminal End View 1.7L Throttle Body Injection NIVA (2 of 2)

2.8 ELECTRONIC CONTROL MODULE TERMINALS DEFINED

ELECTRONIC CONTROL MODULE CONNECTOR VOLTAGES WITH EXPLANATIONS

A1 FUEL SYSTEM RELAY CONTROL - Turning the ignition "ON" signals the electronic control module to energize (+12V) the fuel system relay. If no crankshaft reference input pulses are received, the electronic control module turns "OFF" the relay. When the electronic control module receives crankshaft reference input (terminal "B5") the electronic control module turns the fuel pump relay back "ON."

A2 NO CONNECTION

A3 PULSE WIDTH MODULATED CANISTER CONTROL - The electronic control module supplies the ground circuit to energize the evaporative emission storage canister control solenoid. With the engine stopped this terminals should equal the battery voltage. With the engine running, the voltage will be between battery voltage and zero. The voltage level will depend on the 0%–100% pulse width modulated control signal sent to the canister solenoid.

A4 NO CONNECTION

A5 CHECK ENGINE LIGHT CONTROL - The electronic control module supplies the ground to turn the "Check Engine" light "ON". With the ignition "ON" and the engine not running, the "Check Engine" light should be "ON," terminal "A5" voltage is close to zero. With the "Check Engine" light not "ON," the voltage at terminal "A5" is battery voltage.

A6 IGNITION SWITCH VOLTAGE INPUT SIGNAL - This is the "turn on" signal to the electronic control module from the ignition switch circuit. It is *not* the "power supply" to the electronic control module; it signals the electronic control module the ignition is "ON." The voltage equals battery voltage when the ignition switch is in either the 'run' or 'crank' position.

A7 NO CONNECTION

A8 SERIAL DATA COMMUNICATIONS - From terminal "A8" the electronic control module sends out information (data) about its inputs and outputs to the assembly line data link terminal "M". This data is sent as a string of rapidly changing voltage signals pulsed from high (+5 volts) to low (0 volts). The Tech 1 "Scan" tool, when connected, interprets the varying square-wave signal and displays the data. The data is sent in a serial fashion; that is, one piece after the other until all the information has been sent—then the process begins again. Voltage, when measured with a digital voltmeter, will rapidly change between 1 and 5 volts.

A9 DIAGNOSTIC "TEST" TERMINAL INPUT SIGNAL - This terminal is connected to the assembly line data link diagnostic "test" terminal "B". When the diagnostic "test" terminal is not grounded, this terminal will have 5 volts on it. When the assembly line data link diagnostic "test" terminal is grounded, the resulting zero voltage at the electronic control module causes it to operate in the Diagnostic Mode or the Field Service Mode, depending if the engine is stopped or running.

A10 VEHICLE SPEED INPUT SIGNAL - The electronic control module sends a +12V *signal* voltage to the vehicle speed sensor. The vehicle speed sensor *pulses* the signal to ground, these pulses vary in frequency with the speed of the car.

A11 COOLANT TEMPERATURE AND THROTTLE POSITION SENSOR GROUND - This terminal should be nearly zero volts. It is connected through the electronic control module circuitry to engine ground.

A12 ELECTRONIC CONTROL MODULE GROUND - This terminal has nearly zero volts. It is connected directly to the engine at the direct ignition system mounting bracket.

B1 BATTERY + (Power Supply) - This terminal "B1" supplies the electronic control module with full-time +12 volts. It is hot even when the ignition is turned "OFF." It receives voltage through the fusible link. This electronic control module terminal could be called the power supply and "MEMORY" terminal, along with terminal "C16".

B2 NO CONNECTION

B3 CRANKSHAFT REFERENCE LOW - This terminal is always nearly zero volts. It is connected through the ignition module to engine ground.

B4 NO CONNECTION

B5 CRANKSHAFT REFERENCE INPUT SIGNAL - This terminal could be called the "tach" input. It provides the electronic control module with revolutions per minute and crankshaft position information. With ignition "ON," but the engine not running, the voltage is less than 1 volt. As the crankshaft turns, the voltage increases with revolutions per minute.

B6 NO CONNECTION

B7 NO CONNECTION

B8 AIR CONDITIONING REQUEST INPUT SIGNAL - When the instrument panel air conditioning switch is "OFF," the voltage at this terminal is near zero. When the switch is "ON," a +12 volt signal is sent to the electronic control module.

B9 NO CONNECTION

B10 NO CONNECTION

B11 NO CONNECTION

B12 OCTANE ADJUSTMENT INPUT SIGNAL - The octane adjust potentiometer output voltage, which depends on the potentiometer voltage adjustment, is variable from 1–5 volts. By monitoring this output voltage, the electronic control module makes small changes in the total spark advance to allow for low octane fuel.

C1 NO CONNECTION

C2 INTAKE MANIFOLD ELECTRIC HEATER RELAY CONTROL - This terminal has battery voltage until the electronic control module energizes the relay by supplying the ground, then the voltage is close to zero. The input that causes the electronic control module to energize the relay is C10 - COOLANT TEMPERATURE SENSOR. The electronic control module also energizes the relay in the Diagnostic Mode - ignition "ON," the engine not running with the assembly line data link diagnostic "test" terminal "B" jumpered to "A".

C3, C4, C5, C6 IDLE AIR CONTROL COILS - These terminals are connected to the idle air control valve, located on the throttle body. It is difficult to predict what the voltage will be, and the measurement is not usable for service procedures.

C7 NO CONNECTION

C8 NO CONNECTION

C9 NO CONNECTION

C10 COOLANT TEMPERATURE INPUT SIGNAL - The electronic control module sends a 5 volt signal to the coolant temperature sensor—a temperature-variable-resistor, called a thermistor. The sensor, also connected to ground, varies the voltage based on engine coolant temperature. As the engine coolant temperature increases, the voltage on terminal "C10" decreases. At 0°C engine coolant temperature, the voltage is above 4 volts. At normal operating temperature (85°C to 100°C) the voltage is less than 2 volts.

C11 MANIFOLD ABSOLUTE PRESSURE INPUT SIGNAL - The voltage on terminal "C11" varies with intake manifold pressure. The sensor monitors intake manifold pressure by a small hose connected to the sensor from the throttle body. With the ignition "ON" and the engine not running (high manifold pressure) the voltage is above 4 volts. This is the barometric pressure measurement, and this voltage changes with both barometric pressure and altitude. When the engine is running at idle, the manifold pressure is quite low due to engine vacuum; therefore, the voltage is also low -1 to 2 volts. The voltage is variable, mostly from engine intake manifold pressure changes, but it can change with barometric pressure or altitude changes. This is typically called the "engine load" input.

C12 INTAKE AIR TEMPERATURE INPUT SIGNAL - The electronic control module sends a 5 volt signal to the air temperature sensor—a temperature-variable-resistor, called a thermistor. The sensor, also connected to ground, varies the voltage based on intake air temperature. As the intake air temperature increases, the voltage on terminal "C12" decreases. At 0°C intake air temperature, the voltage is above 4 volts. At normal operating temperature (85°C to 100°C) the voltage is less than 2 volts.

C13 THROTTLE POSITION INPUT SIGNAL - The throttle position sensor input voltage, which follows actual throttle changes, is variable from 0 to 5 volts. Typically the voltage is less than 1 volt at idle, and 4 to 5 volts at wide-open throttle.

C14 + 5 VOLTS REFERENCE - This voltage is always nearly 5 volts with the ignition "ON." It is a regulated voltage output from the electronic control module, and supplies 5 volts to the manifold absolute pressure and throttle position sensors.

C15 NO CONNECTION

C16 BATTERY + (POWER SUPPLY) - See terminal "B1".

D1 ELECTRONIC CONTROL MODULE GROUND - This terminal has nearly zero volts, it is connected directly to the engine at the direct ignition system mounting bracket.

D2 OCTANE ADJUST, MANIFOLD ABSOLUTE PRESSURE, AND INTAKE AIR TEMPERATURE SENSOR GROUND - This terminal is nearly zero volts, it is connected through the electronic control module to engine ground.

D4 ELECTRONIC SPARK TIMING OUTPUT - This terminal has very low voltage with the ignition "ON," but the engine not running. With the engine running at idle, the voltage is slightly more than 1 volt. As the engine revolutions per minute goes up, this voltage increases.

D5 IGNITION MODULE BYPASS MODE CONTROL - With ignition "ON" and the engine not running this terminal has very low voltage. When the electronic control module measures more than 500 revolutions per minute (engine "RUN" threshold) on B5 - CRANKSHAFT REFERENCE INPUT SIGNAL, the electronic control module turns on 5 volts to D5 - IGNITION MODULE BYPASS MODE CONTROL CIRCUIT.

D6 OXYGEN SENSOR GROUND CIRCUIT - This terminal should have zero volts. It is connected directly to the engine block at the ignition module bracket. This terminal grounds the electronic control module circuitry for the oxygen sensor voltage monitor inside the electronic control module.

D7 OXYGEN SENSOR INPUT SIGNAL- With ignition "ON" and engine not running, the voltage should drop from a starting point of approximately 0.450 volt to less than 0.200 volts. The oxygen sensor is electrically heated. When the engine is not running and the sensor is hot an abundance of oxygen in the exhaust manifold will be sensed and the sensor's output voltage would be less than 0.200 volts. If the sensor's electric heater is malfunctioning, the only voltage seen here with the engine stopped would be the "reference" voltage coming from the electronic control module. This reference voltage is a steady 400-500 mV (0.400-0.500 volt). With the engine running and after the oxygen sensor is hot, the voltage should be rapidly changing, somewhere between 10-1000 millivolts (.010-1.00 volts).

D8 NO CONNECTION

D9, D10 INJECTOR CIRCUIT, CURRENT LIMITER JUMPER - The electronic control module's injector control circuit uses this jumper to complete its path to ground through an internal current limiter. If this jumper circuit is open or missing, the vehicle will not start. If the circuit is shorted to ground the vehicle may run, but with reduced performance and poor driveability and would eventually cause the fuel injector to not operate.

D11 NO CONNECTION

D12 AIR CONDITIONING COMPRESSOR CLUTCH RELAY CONTROL - The electronic control module supplies the ground path on this terminal to energize the air conditioning compressor clutch control relay. The voltage is less than 1 volt when the electronic control module energizes the relay, but the voltage is also less than 1 volt if the electronic control module does not receive the "Air Conditioning Request" input voltage at terminal "B8".

D13 NO CONNECTION

D14 NO CONNECTION

D15 NO CONNECTION

D16 FUEL INJECTOR CONTROL - The voltage at this terminal comes through the injector which is connected to +12 volts. With the ignition "ON," and the engine not running, the voltage is equal to battery voltage. With the engine at idle, the charging system increases this battery voltage slightly. With higher engine revolutions per minute or more engine load, the increased injector pulse frequency and injector pulse width causes the voltage to be slightly less than at idle.

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SECTION 2.9A

DIAGNOSTIC CHARTS

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2.9 DIAGNOSTIC CHARTS DEFINED

INTRODUCTION

The diagnostic charts are designed to provide fast and efficient fault location for the fuel system, electronic spark timing system and all other engine functions associated with the electronic control module. Each diagnostic chart uses 2 pages; a "trouble tree chart" on the right side page, and a "facing page" on the left side page. The left side "facing page" contains pertinent information, including malfunction code setting parameters and circuit diagrams. The trouble tree boxes with circled numbers are explained by the corresponding numbered paragraph on the left side facing page.

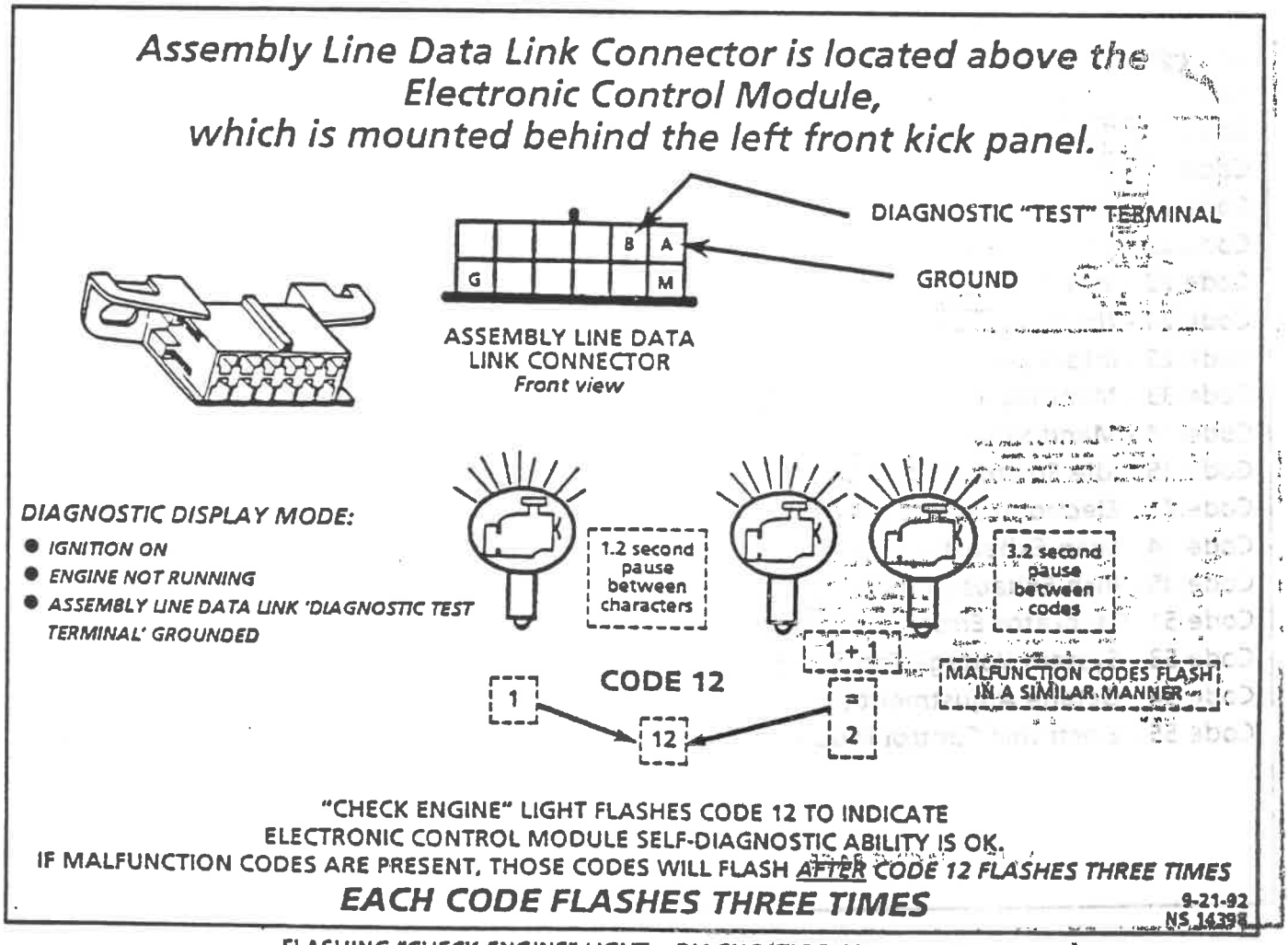
It is essential that the charts be used correctly. *When diagnosing any problem,* **ALWAYS BEGIN WITH THE DIAGNOSTIC CIRCUIT CHECK!** The Diagnostic Circuit Check will lead you into the other charts. DO NOT GO DIRECTLY TO A SPECIFIC CHART or false diagnosis and replacement of "good" parts could result.

After a fault is corrected and all codes have been cleared, it is advisable to repeat the Diagnostic Circuit Check to ensure that proper repairs have been made.

When the electronic control module is operating in the DIAGNOSTIC MODE, the "Check Engine" light will flash stored malfunction codes.

Each code displayed consists of a number of flashes representing the first digit followed by a short pause, then a number of flashes representing the second digit, followed by a longer pause indicating the end of the code.

Each stored code is displayed three times before proceeding to the next code. After all codes stored in memory have been displayed, the entire flashing sequence is repeated.


Assembly Line Data Link Connector is located above the Electronic Control Module, which is mounted behind the left front kick panel.
DIAGNOSTIC "TEST" TERMINAL
GROUND
B
A
G
M
ASSEMBLY LINE DATA LINK CONNECTOR
Front view
DIAGNOSTIC DISPLAY MODE:
IGNITION ON
ENGINE NOT RUNNING
ASSEMBLY LINE DATA LINK 'DIAGNOSTIC TEST TERMINAL' GROUNDED
1.2 second pause between characters
3.2 second pause between codes
1 + 1
MALFUNCTION CODES FLASH IN A SIMILAR MANNER
CODE 12
1
12
=
2
"CHECK ENGINE" LIGHT FLASHES CODE 12 TO INDICATE
ELECTRONIC CONTROL MODULE SELF-DIAGNOSTIC ABILITY IS OK.
IF MALFUNCTION CODES ARE PRESENT, THOSE CODES WILL FLASH AFTER CODE 12 FLASHES THREE TIMES
EACH CODE FLASHES THREE TIMES
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FLASHING "CHECK ENGINE" LIGHT - DIAGNOSTIC DISPLAY MODE

Each diagnostic chart uses 2 pages: a "trouble-tree chart" on the right side page, and a "facing page" on the left side page. The left side "facing page" contains pertinent information, including malfunction code setting parameters and circuit diagrams.

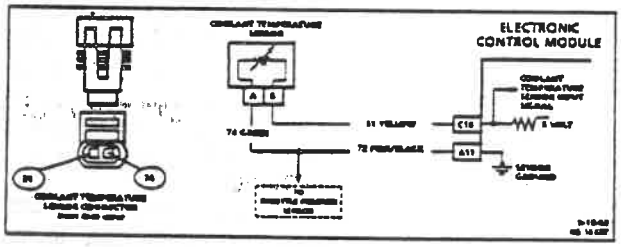
Troubleshooting is performed by using the "trouble-tree" page. Extra information, such as the reasoning behind certain tests, will be listed on the "facing" page.

TROUBLE TREE BOXES WITH CIRCLED NUMBERS (right side chart page)

are explained by the

CORRESPONDING NUMBERED PARAGRAPH (left side chart page)

FACING PAGE



CODE 14
COOLANT TEMPERATURE
(SIGNAL VOLTAGE TOO LOW)
1.7L THROTTLE BODY INJECTION NIVA

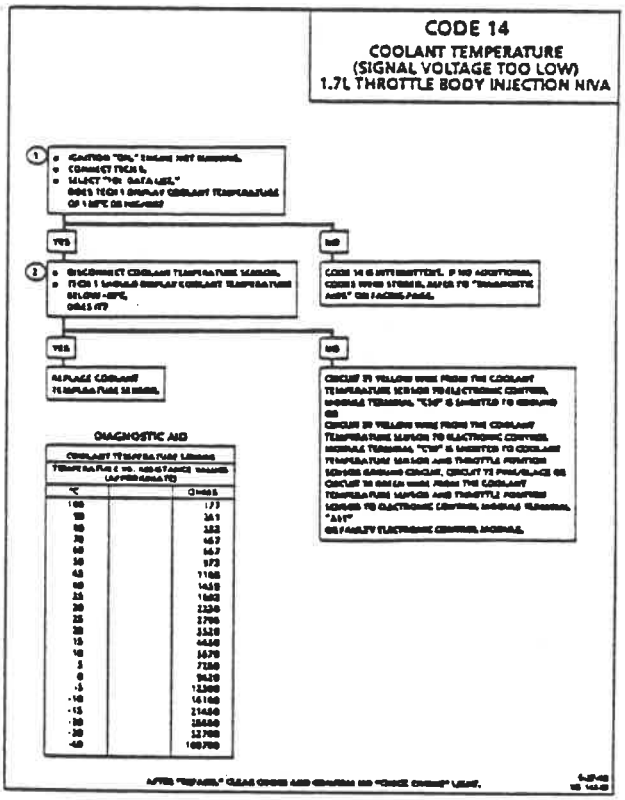
Circuit Description:

Test Description:

Diagnostic Aids:

TYPICAL FACING PAGE

TROUBLE-TREE CHART PAGE



TYPICAL DIAGNOSTIC CHART

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2.9A DIAGNOSTIC CHARTS

TECH 1 "SCAN" TOOL TYPICAL DATA VALUE

The Tech 1 "Scan" Data listed in the table may be used for comparison, after completing the Diagnostic Circuit Check and finding the on-board diagnostics functioning properly and no diagnostic codes displayed.

A TECH 1 "SCAN" TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY TECH 1 "SCAN" TOOL CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

Only the parameters listed are used in this manual for diagnosing. For more description on the typical data values, to diagnosis electronic control module inputs, refer to the "General Description and System Operation," Section "1". If all data values are within the ranges illustrated, refer to "2-B" "Symptom Charts."

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. The "Scan" position refers to the Tech 1 "F0: DATA LIST" display pairs that are displayed in order, if the "YES" button is pressed. After "Time From Start" parameter is displayed, by pressing the "YES" button, the display pairs will start on the top of list again.
2. "Units Displayed" are the available ways of displaying what each parameter is currently operating in, or a value that is being sensed or being outputted.
3. "Typical Data Value" is separated into two parts. These displayed values are typical of a normally operating vehicle. The ignition "ON" comparison should be performed first as this may lead to a quick identification of a failure. The Engine Running data should be compared to the ignition "ON" data as a diagnostic check to make sure the component or system is operating properly.
4. Ignition "ON" values are the typical values that should be seen on the Tech 1 "Scan" tool with the ignition "ON," and engine not running. Temperature sensors should be compared to the actual temperatures by letting the sensor sit overnight and then comparing their values. A difference of +5°C from the actual temperature may indicate a problem with the sensor. Use the diagnostic aids chart for that sensor to compare the resistance to temperature values.

   Some "ON" or "OFF" switches may display an abnormal state. If the chart states this position is abnormal, then this may be caused by an open or short to ground, depending upon the normal state of the switch. Refer to "General Description and Operation" Section "1" for more information.
5. "ENGINE RUNNING" typical data values are an average of display values recorded from normally operating vehicles, and are intended to represent what a normally functioning system would typically display.

TECH 1 "SCAN" DATA

① "SCAN" POSITION	② UNITS DISPLAYED	③ TYPICAL DATA VALUE, A/C "OFF", ENGINE WARM		REFER TO SECTION
		④ IGNITION "ON"	⑤ ENGINE IDLING	
ENGINE SPEED	REVOLUTIONS PER MINUTE	0	± 50 FROM DESIRED IDLE	1.2
DESIRED IDLE	REVOLUTIONS PER MINUTE	VARIES	ELECTRONIC CONTROL MODULE IDLE COMMAND (VARIES WITH TEMPERATURE)	1.2
COOLANT TEMPERATURE	°C	SHOULD EQUAL ACTUAL TEMP.	85° – 110°C	1.1
INTAKE AIR TEMPERATURE	°C		VARIES WITH AMBIENT AND UNDERHOOD AIR TEMPERATURE	1.1
MANIFOLD ABSOLUTE PRESSURE	KPA/VOLTS	75 TO 105 KPA 3.5 TO 5.0 VOLTS	DEPENDS ON BAROMETRIC PRESSURE AND ENGINE LOAD	1.1
BAROMETRIC PRESSURE	KPA	VARIES WITH ALTITUDE	DEPENDS ON BAROMETRIC PRESSURE	1.1
THROTTLE POSITION	VOLTS	.35 – .70	.35 – .70	1.1
THROTTLE ANGLE	0–100%	0%	0%	1.1
VEHICLE SPEED	KILOMETERS PER HOUR	0	0	1.1
SYSTEM VOLTAGE	VOLTS	11.5 –14.0	12.0 –15.0	1.2
OXYGEN SENSOR VOLTAGE	MILLIVOLTS	LESS THAN 200 mV	95mV to 950mV	1.1
OPEN/CLOSED LOOP FUEL CONTROL	OPEN/CLOSED	OPEN	"CLOSED LOOP" WITHIN 5 MINUTES AFTER STARTING ENGINE	1.2
POWER ENRICHMENT MODE ACTIVE	YES/NO	NO	NO	1.2
OXYGEN SENSOR READY	YES/NO	YES	SHOULD REMAIN "YES" AFTER STARTING ENGINE	1.1
EXHAUST GASES	RICH/LEAN	LEAN	VARIES WITH OXYGEN SENSOR'S INTERPRETATION OF EXHAUST GASES	1.1
DECEL FUEL CUT MODE IN EFFECT	YES/NO	NO	NO	1.2

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TECH 1 "SCAN" DATA

① "SCAN" POSITION	② UNITS DISPLAYED ④	③ TYPICAL DATA VALUE, A/C "OFF" ENGINE WARM		REFER TO SECTION
		IGNITION "ON"	⑤ ENGINE IDLING	
ADAPTIVE MEMORY FUEL ADJUSTMENT	- 100% – + 100%	0%	FLUCTUATES WITH CHANGE IN MEMORY FUEL ADJUSTMENT NORMALLY BETWEEN -10% AND + 10%	1.2
FUEL MEMORY CELL	0-35		35	1.2
"CLOSED LOOP" FUEL ADJUSTMENT	- 100% – + 100%	0%	FLUCTUATES WITH CHANGE IN "CLOSED LOOP" FUEL ADJUSTMENT NORMALLY BETWEEN -20% AND +20% WHEN OPERATING IN "CLOSED LOOP"	1.2
SPARK ADVANCE	0 BEFORE TOP DEAD CENTER TO 60 BEFORE TOP DEAD CENTER	NOT USEABLE	VARIES	1.4
FUEL INJECTOR PULSE WIDTH	MILLISECONDS	3.9 OR HIGHER	.8 TO 1.5	1.2
AIR FUEL RATIO		NOT USEABLE	13.5 – 14.7	1
CALIBRATION IDENTIFICATION	VARIES	VARIES	VARIES	1.1
ENGINE RUNNING TIME SINCE LAST START UP	HOURS/MINUTES/ SECONDS	NOT USEABLE	VARIES WITH TIME	2.3
IDLE AIR CONTROL POSITION	COUNTS	135	5-50	1.2
AIR CONDITIONING REQUEST SIGNAL	YES/NO	NO	CHANGES WITH REQUEST FOR AIR CONDITIONING	1.1
AIR CONDITIONING COMPRESSOR CONTROL RELAY	ON/OFF	OFF	CHANGES WITH COMPRESSOR STATUS	1.1
OCTANE ADJUSTMENT	VOLTS DEGREES	0.00 VOLT 0° TO -8°	1.0 VOLT TO 4.7 VOLT 0° TO -8°	1.1
EVAPORATIVE EMISSION CANISTER PURGE DUTY CYCLE	0 – 100%	0%	0%	1.3
INTAKE MANIFOLD HEATER CONTROL RELAY	OFF/ON	OFF	"ON" OR "OFF" DEPENDING ON COOLANT TEMPERATURE AND INTAKE AIR TEMPERATURE	1.9
FUEL PUMP CIRCUIT	ON/OFF	"ON" MOMENTARILY THEN "OFF"	"ON"	1.2
RADIATOR FAN	NOT USED	NOT USED		1.2

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ELECTRONIC CONTROL MODULE DIAGNOSTIC CODES

CODE	DESCRIPTION	TURN ON CHECK ENGINE LIGHT?
13	NO OXYGEN SENSOR SIGNAL	YES
14	COOLANT TEMPERATURE - Signal voltage too low	YES
15	COOLANT TEMPERATURE - Signal voltage too high	YES
21	THROTTLE POSITION - Signal voltage too high	YES
22	THROTTLE POSITION - Signal voltage too low	YES
23	INTAKE AIR TEMPERATURE - Signal voltage too high	YES
24	NO VEHICLE SPEED SIGNAL	YES
25	INTAKE AIR TEMPERATURE - Signal voltage too low	YES
33	MANIFOLD ABSOLUTE PRESSURE - Signal voltage too high	YES
34	MANIFOLD ABSOLUTE PRESSURE - Signal voltage too low	YES
35	IDLE SPEED ERROR	YES
42	ELECTRONIC SPARK TIMING - Control Circuit problem	YES
44	LEAN EXHAUST INDICATION	YES
45	RICH EXHAUST INDICATION	YES
51	CALIBRATOR ERROR	YES
53	SYSTEM VOLTAGE TOO HIGH	YES
54	OCTANE ADJUSTMENT CIRCUITS - Signal voltage too high or too low	YES
55	ELECTRONIC CONTROL MODULE ERROR	YES

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NS 14410

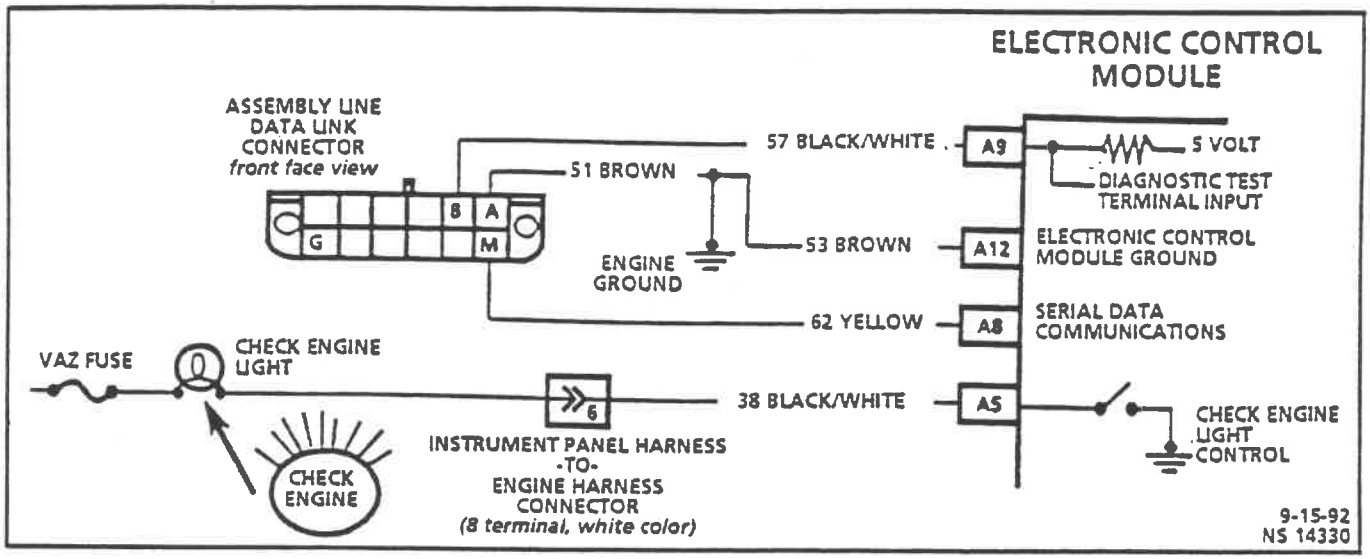


CHART A

DIAGNOSTIC CIRCUIT CHECK 1,7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The diagnostic circuit check is an organized approach to identifying a problem created by an electronic engine control system malfunction. It must be the starting point for any driveability complaint diagnosis, because it directs the service technician to the next logical step in diagnosing the complaint. Understanding the chart and using it correctly will reduce diagnosis time and prevent the unnecessary replacement of good parts.

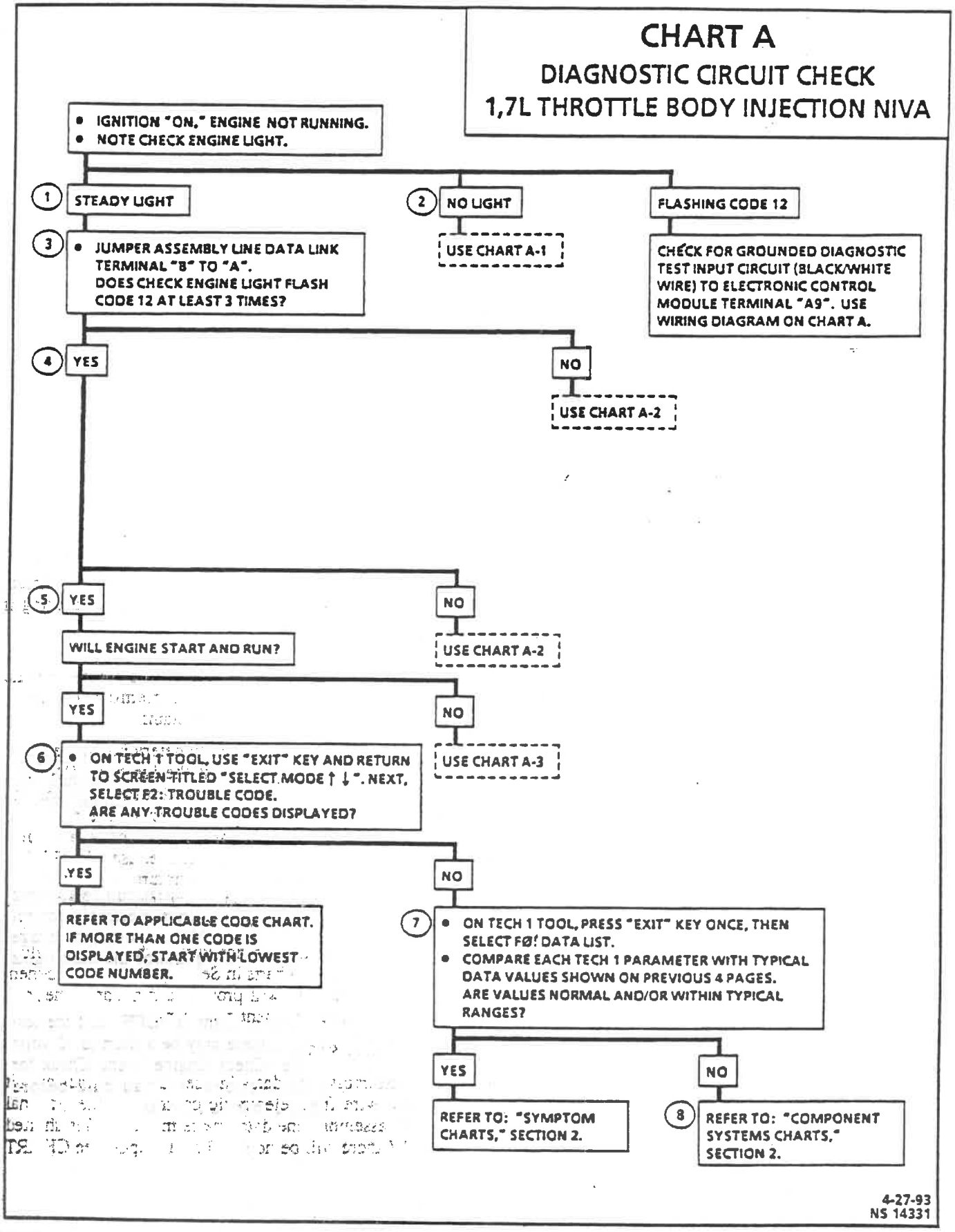
Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. This check is to see if the bulb is OK.
2. If the "Check Engine" light is "OFF," CHART A-1 will check for both ignition feed and constant battery power to the electronic control module and the electronic control module grounds.
3. This check is done to see if the electronic control module has the capability to control the "Check Engine" light. With the assembly line data link diagnostic "test" terminal "B" grounded, the "Check Engine" light will flash Code 12 at least three times followed by any diagnostic codes stored in memory. Code 12 means there is no crankshaft reference signal coming to the electronic control module, this is normal because the engine is not running.
4. This check is used to see if the electronic control module can supply serial data for Tech 1 "Scan" tool use. If an engine calibrator error is present, the electronic control module may have the ability to flash a Code 12 but not enable serial data.
5. This test is used to see if "Cranks But Will Not Run" symptom is caused by an electronic control module problem or the vehicle electrical system.
6. This check is to see if the electronic control module has any codes stored in its memory to aid in diagnosing the customer complaint.
7. Look at all the parameters to determine if one is not in a normal state with just the ignition "ON" and engine not running. In particular, look at the barometric pressure reading from the manifold absolute pressure sensor voltage and kPa values. Are they normal for your altitude, use CHART C1-D. Look at the coolant temperature sensor value to see if the value is reasonable or if it is shifted above or below where it should be.
8. If the actual data is not within the typical values established, the charts in Section "2-C" "Component Systems Charts" will provide a functional check of the suspect component or system.

Diagnostic Aids:

If assembly line data link serial data output circuit (Yellow, wire from electronic control module terminal "A8" to assembly line data link terminal "M") is shorted to +12V, there will be no serial data output. See CHART A-2.

CHART A
DIAGNOSTIC CIRCUIT CHECK
1,7L THROTTLE BODY INJECTION NIVA


• IGNITION "ON," ENGINE NOT RUNNING.
• NOTE CHECK ENGINE LIGHT.
1
STEADY LIGHT
2
NO LIGHT
FLASHING CODE 12
3
• JUMPER ASSEMBLY LINE DATA LINK TERMINAL "B" TO "A". DOES CHECK ENGINE LIGHT FLASH CODE 12 AT LEAST 3 TIMES?
USE CHART A-1
CHECK FOR GROUNDED DIAGNOSTIC TEST INPUT CIRCUIT (BLACK/WHITE WIRE) TO ELECTRONIC CONTROL MODULE TERMINAL "A9". USE WIRING DIAGRAM ON CHART A.
4
YES
NO
USE CHART A-2
5
YES
NO
WILL ENGINE START AND RUN?
USE CHART A-2
YES
NO
6
• ON TECH 1 TOOL, USE "EXIT" KEY AND RETURN TO SCREEN TITLED "SELECT MODE ↑ ↓". NEXT, SELECT F2: TROUBLE CODE. ARE ANY TROUBLE CODES DISPLAYED?
USE CHART A-3
YES
NO
REFER TO APPLICABLE CODE CHART. IF MORE THAN ONE CODE IS DISPLAYED, START WITH LOWEST CODE NUMBER.
7
• ON TECH 1 TOOL, PRESS "EXIT" KEY ONCE, THEN SELECT F0: DATA LIST.
• COMPARE EACH TECH 1 PARAMETER WITH TYPICAL DATA VALUES SHOWN ON PREVIOUS 4 PAGES. ARE VALUES NORMAL AND/OR WITHIN TYPICAL RANGES?
YES
NO
REFER TO: "SYMPTOM CHARTS," SECTION 2.
8
REFER TO: "COMPONENT SYSTEMS CHARTS," SECTION 2.

4-27-93
NS 14331

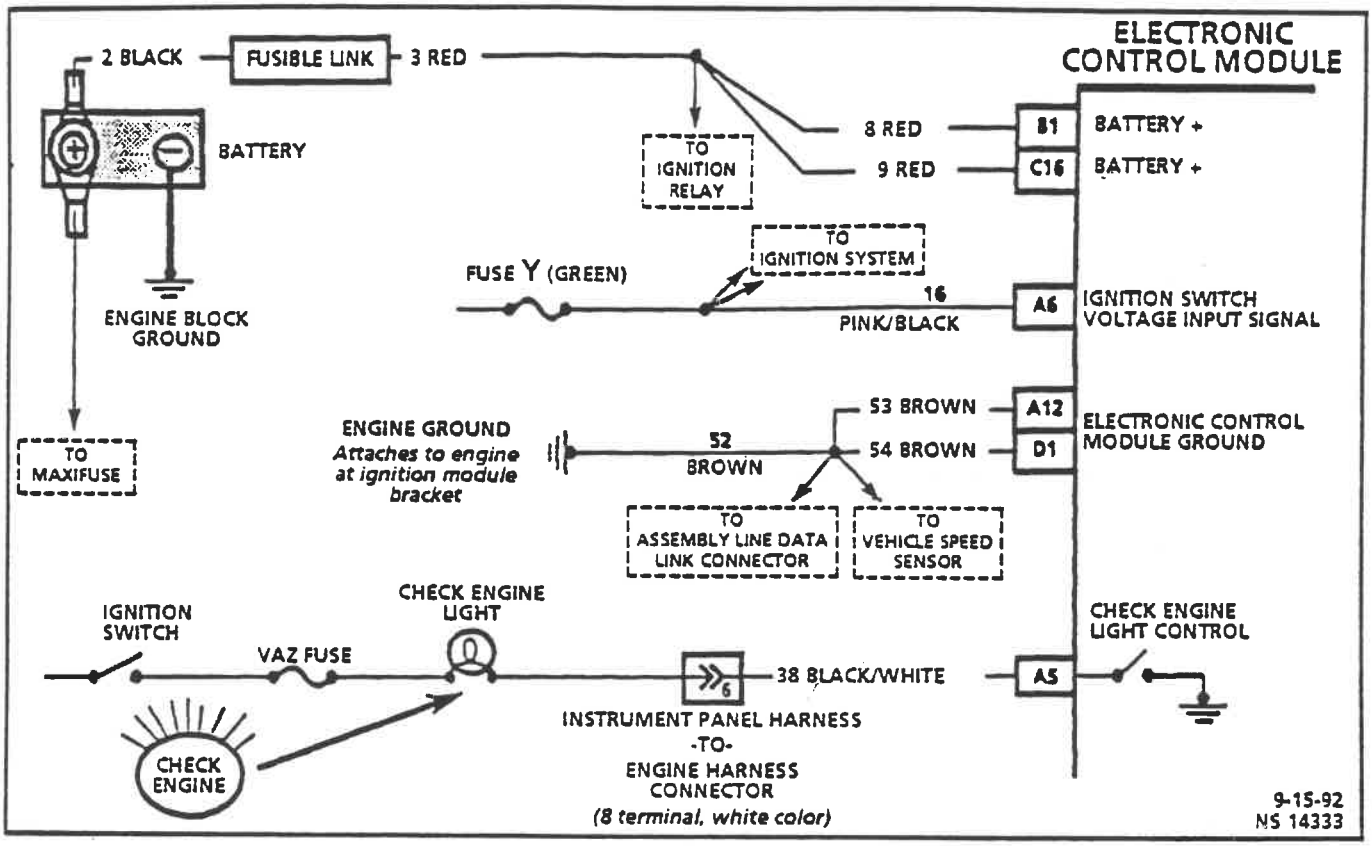


CHART A-1

NO "CHECK ENGINE" LIGHT
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

There should always be a steady "Check Engine" light, when the ignition is "ON" and the engine is not running. Switched ignition voltage is supplied from VAZ fuse directly to the light bulb. The electronic control module will control the light and turn it "ON" by providing a ground path through the Black/White wire to electronic control module terminal "A5".

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

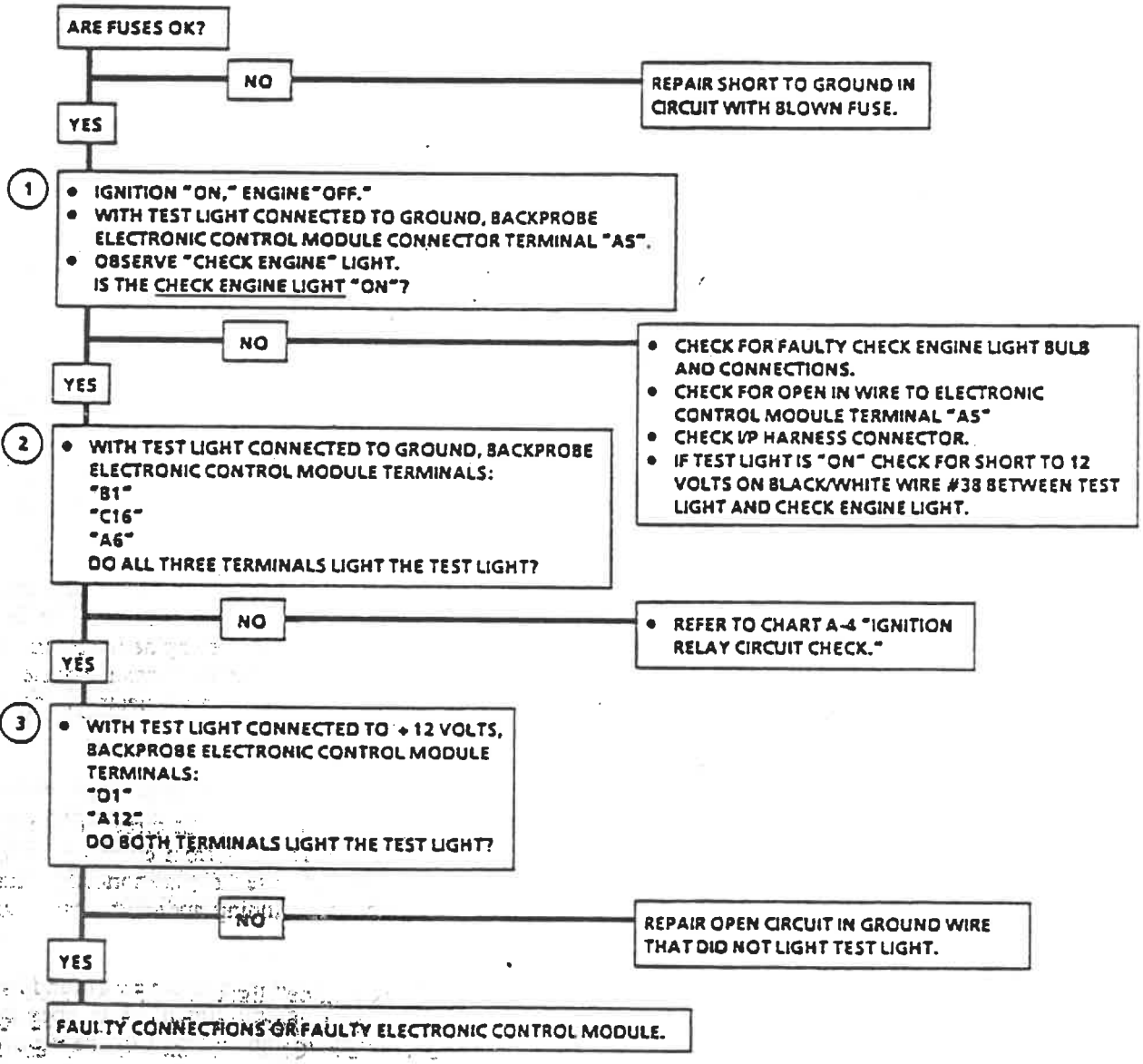
1. Step 1 checks the operation of the control circuit wire to the electronic control module connector terminal "A5".
2. This step checks the electronic control module is receiving power on its three power supply terminals: "B1", "C16", and "A6".
3. This step checks the electronic control module-to-engine block ground circuits on electronic control module connector terminals "A12" and "D1".

Diagnostic Aids:

If ignition switch voltage input circuit (electronic control module Pink/Black wire from electronic control module terminal "A6" to Fuse "Y") is shorted to voltage the engine will not stop running and/or the dash lights will be "ON."

If the "Check Engine" light is "OFF" and the test light is "ON" in Step 1, there may be a short to 12 volts between "A5" and the "Check Engine" light. Check for open wires, bad connections or a bad bulb before assuming that there is a short to 12 volts.

CHART A-1
NO "CHECK ENGINE" LIGHT
1.7L THROTTLE BODY INJECTION NIVA


ARE FUSES OK?
NO
REPAIR SHORT TO GROUND IN CIRCUIT WITH BLOWN FUSE.
YES
1
• IGNITION "ON," ENGINE "OFF."
• WITH TEST LIGHT CONNECTED TO GROUND, BACKPROBE ELECTRONIC CONTROL MODULE CONNECTOR TERMINAL "A5".
• OBSERVE "CHECK ENGINE" LIGHT.
IS THE CHECK ENGINE LIGHT "ON"?
NO
• CHECK FOR FAULTY CHECK ENGINE LIGHT BULB AND CONNECTIONS.
• CHECK FOR OPEN IN WIRE TO ELECTRONIC CONTROL MODULE TERMINAL "A5"
• CHECK I/P HARNESS CONNECTOR.
• IF TEST LIGHT IS "ON" CHECK FOR SHORT TO 12 VOLTS ON BLACK/WHITE WIRE #38 BETWEEN TEST LIGHT AND CHECK ENGINE LIGHT.
YES
2
• WITH TEST LIGHT CONNECTED TO GROUND, BACKPROBE ELECTRONIC CONTROL MODULE TERMINALS:
"B1"
"C16"
"A6"
DO ALL THREE TERMINALS LIGHT THE TEST LIGHT?
NO
• REFER TO CHART A-4 "IGNITION RELAY CIRCUIT CHECK."
YES
3
• WITH TEST LIGHT CONNECTED TO + 12 VOLTS, BACKPROBE ELECTRONIC CONTROL MODULE TERMINALS:
"D1"
"A12"
DO BOTH TERMINALS LIGHT THE TEST LIGHT?
NO
REPAIR OPEN CIRCUIT IN GROUND WIRE THAT DID NOT LIGHT TEST LIGHT.
YES
FAULTY CONNECTIONS OR FAULTY ELECTRONIC CONTROL MODULE.

4-27-93
NS 14334

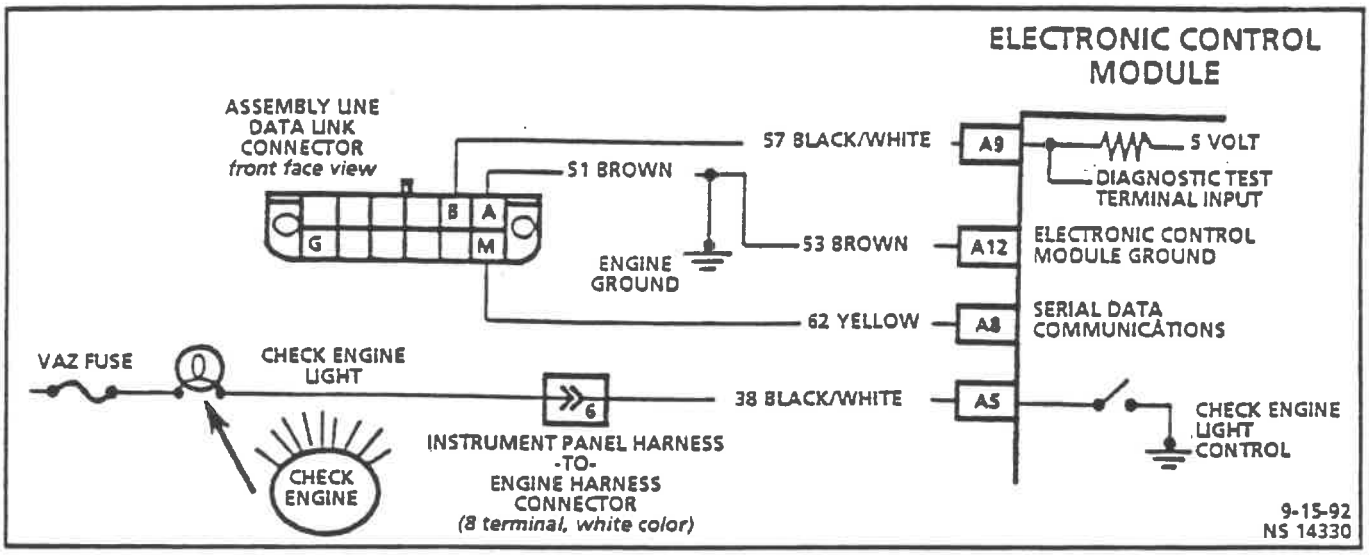


CHART A-2

NO ASSEMBLY LINE DATA LINK SERIAL DATA OR WILL NOT FLASH CODE 12 ("CHECK ENGINE" LIGHT "ON" STEADY) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

There should always be a steady "Check Engine" light when the ignition switch is "ON" and the engine is not running. Switched ignition voltage is supplied directly to the "Check Engine" light bulb. The electronic control module will turn the light "ON" by supplying the ground path on electronic control module terminal "A5".

When the electronic control module's diagnostic "test" terminal "A9" is grounded, the electronic control module commands the "Check Engine" light to flash a Code 12, followed by any code(s) stored in memory. The Tech 1 "Scan" tool, when the "F1: Field Service" key is pressed, supplies a ground for assembly line data link terminal "B".

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

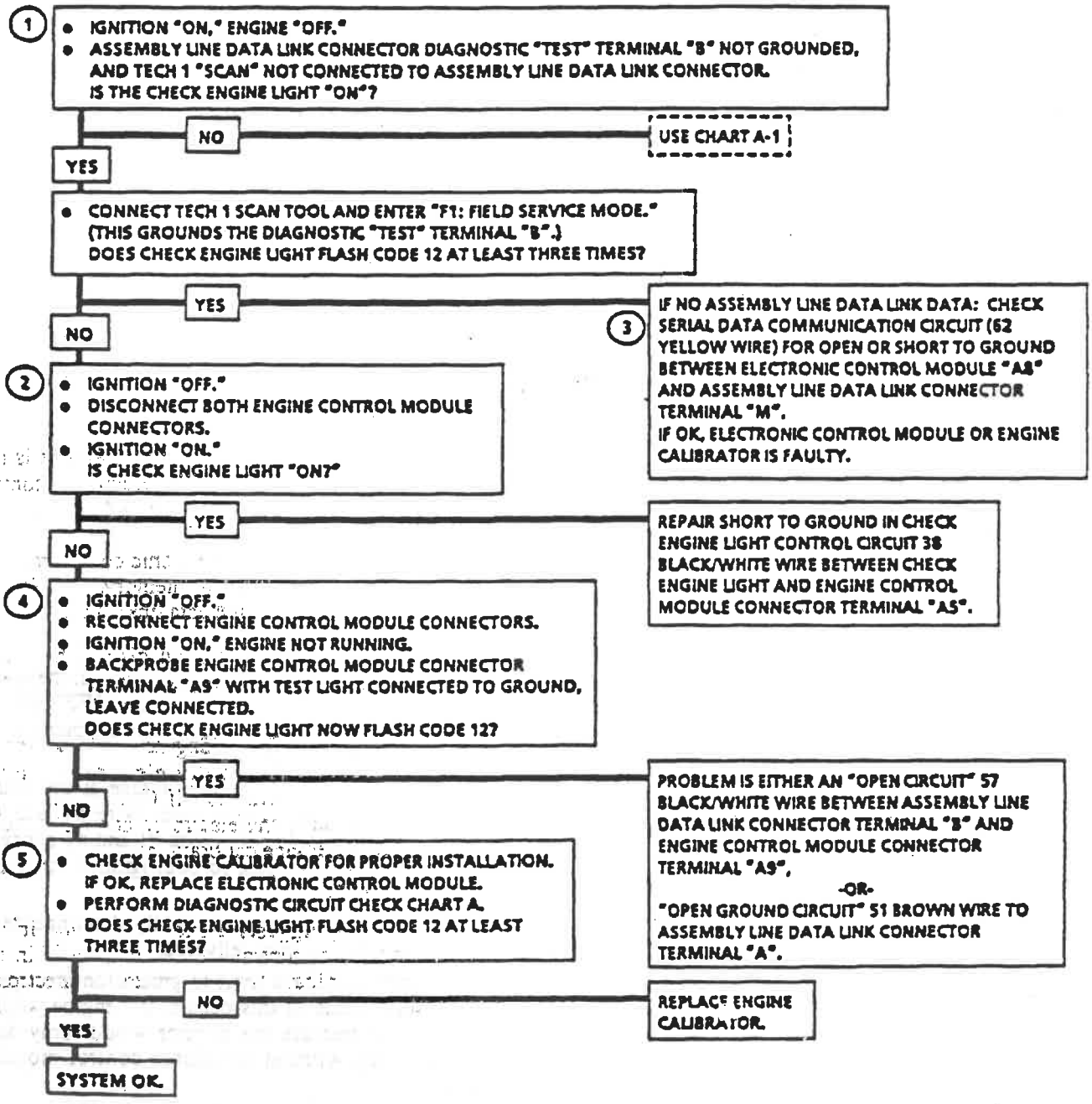
1. If "Check Engine" light is "ON," but very dim and the engine will not start, check connections "D1" and "A12" for proper tightness. Also, ensure that they are clean.
2. If the "Check Engine" light goes "OFF" when the electronic control module connectors are disconnected, then the "Check Engine" light control circuit 38 (Black/White wire) to electronic control module terminal "A5" is not shorted to ground.
3. The electronic control module can flash a Code 12 but may not be able to output serial data to the assembly line data link connector terminal "M". If the Tech 1 "Scan" tool does not display serial data AND the "Check Engine" light is flashing Code 12, THEN check the Tech 1 "Scan" tool on a good vehicle. If the Tech 1 "Scan" tool and the serial data output circuit are OK, then the connections, the electronic control module, or the engine calibrator may be faulty.
4. This step checks for an open circuit between assembly line data link connector terminal "B" and electronic control module terminal "A9".
5. At this point, the "Check Engine" light wiring is OK. The problem is a faulty electronic control module or engine calibrator. If Code 12 does not flash after replacing the electronic control module, then replace the engine calibrator also.

Diagnostic Aids:

A steady light suggests a short to ground in the "Check Engine" light control circuit, or an open in the diagnostic test terminal input circuit to the electronic control module.

CHART A-2

NO ASSEMBLY LINE DATA LINK SERIAL DATA OR WILL NOT FLASH CODE 12 ("CHECK ENGINE" LIGHT "ON" STEADY) 1.7L THROTTLE BODY INJECTION NIVA


1
• IGNITION "ON," ENGINE "OFF."
• ASSEMBLY LINE DATA LINK CONNECTOR DIAGNOSTIC "TEST" TERMINAL "B" NOT GROUNDED, AND TECH 1 "SCAN" NOT CONNECTED TO ASSEMBLY LINE DATA LINK CONNECTOR.
IS THE CHECK ENGINE LIGHT "ON"?
NO
USE CHART A-1
YES
• CONNECT TECH 1 SCAN TOOL AND ENTER "F1: FIELD SERVICE MODE." (THIS GROUNDS THE DIAGNOSTIC "TEST" TERMINAL "B".)
DOES CHECK ENGINE LIGHT FLASH CODE 12 AT LEAST THREE TIMES?
YES
3
IF NO ASSEMBLY LINE DATA LINK DATA: CHECK SERIAL DATA COMMUNICATION CIRCUIT (62 YELLOW WIRE) FOR OPEN OR SHORT TO GROUND BETWEEN ELECTRONIC CONTROL MODULE "A8" AND ASSEMBLY LINE DATA LINK CONNECTOR TERMINAL "M".
IF OK, ELECTRONIC CONTROL MODULE OR ENGINE CALIBRATOR IS FAULTY.
NO
2
• IGNITION "OFF."
• DISCONNECT BOTH ENGINE CONTROL MODULE CONNECTORS.
• IGNITION "ON."
IS CHECK ENGINE LIGHT "ON?"
YES
REPAIR SHORT TO GROUND IN CHECK ENGINE LIGHT CONTROL CIRCUIT 38 BLACK/WHITE WIRE BETWEEN CHECK ENGINE LIGHT AND ENGINE CONTROL MODULE CONNECTOR TERMINAL "A5".
NO
4
• IGNITION "OFF."
• RECONNECT ENGINE CONTROL MODULE CONNECTORS.
• IGNITION "ON," ENGINE NOT RUNNING.
• BACKPROBE ENGINE CONTROL MODULE CONNECTOR TERMINAL "A9" WITH TEST LIGHT CONNECTED TO GROUND, LEAVE CONNECTED.
DOES CHECK ENGINE LIGHT NOW FLASH CODE 12?
YES
PROBLEM IS EITHER AN "OPEN CIRCUIT" 57 BLACK/WHITE WIRE BETWEEN ASSEMBLY LINE DATA LINK CONNECTOR TERMINAL "B" AND ENGINE CONTROL MODULE CONNECTOR TERMINAL "A9",
-OR-
"OPEN GROUND CIRCUIT" 51 BROWN WIRE TO ASSEMBLY LINE DATA LINK CONNECTOR TERMINAL "A".
NO
5
• CHECK ENGINE CALIBRATOR FOR PROPER INSTALLATION. IF OK, REPLACE ELECTRONIC CONTROL MODULE.
• PERFORM DIAGNOSTIC CIRCUIT CHECK CHART A.
DOES CHECK ENGINE LIGHT FLASH CODE 12 AT LEAST THREE TIMES?
NO
REPLACE ENGINE CALIBRATOR.
YES
SYSTEM OK.

9-17-92
NS 14336

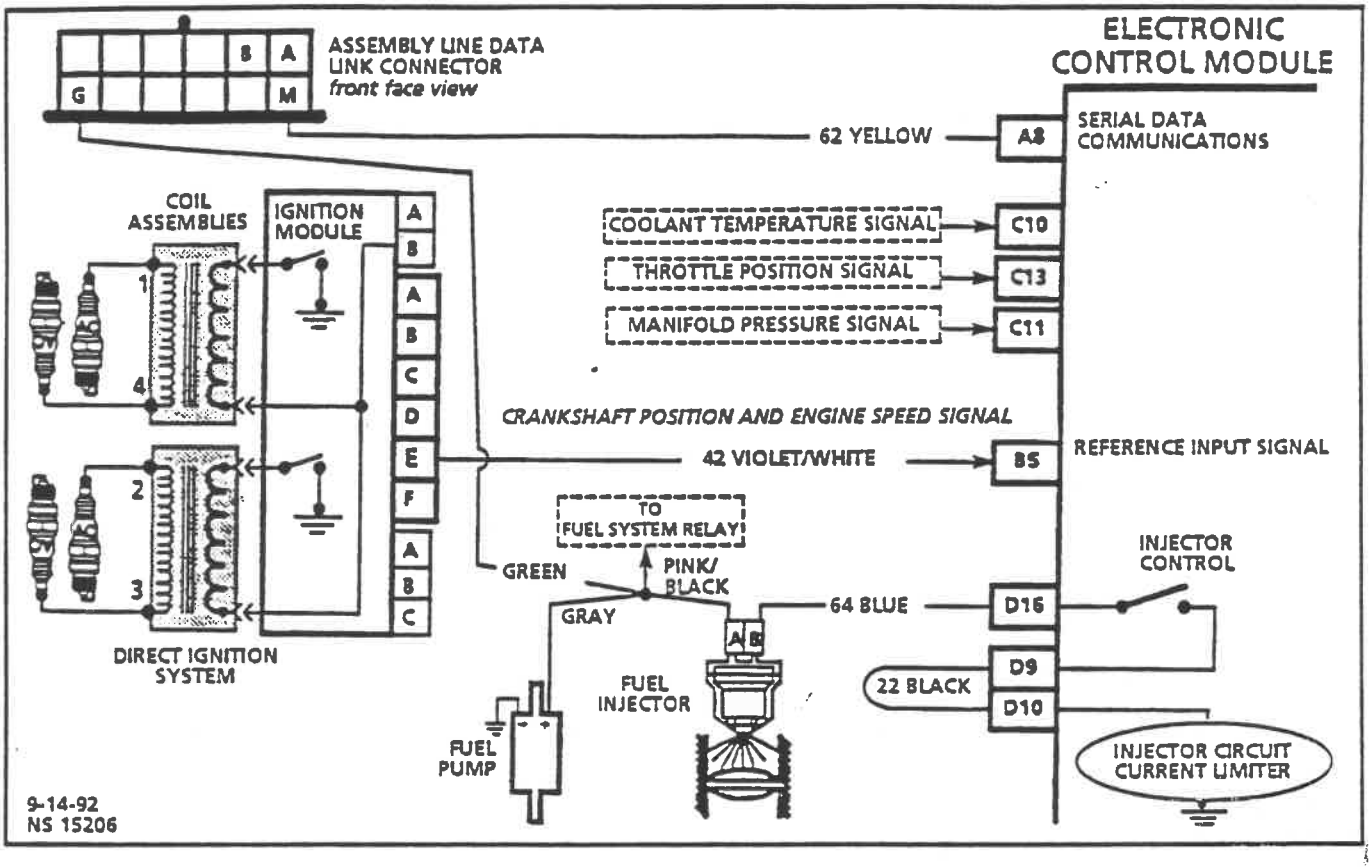


CHART A-3

(Page 1 of 3)
ENGINE CRANKS BUT WILL NOT RUN
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

Before using this chart check: battery condition, engine cranking speed, fuel quantity and quality.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

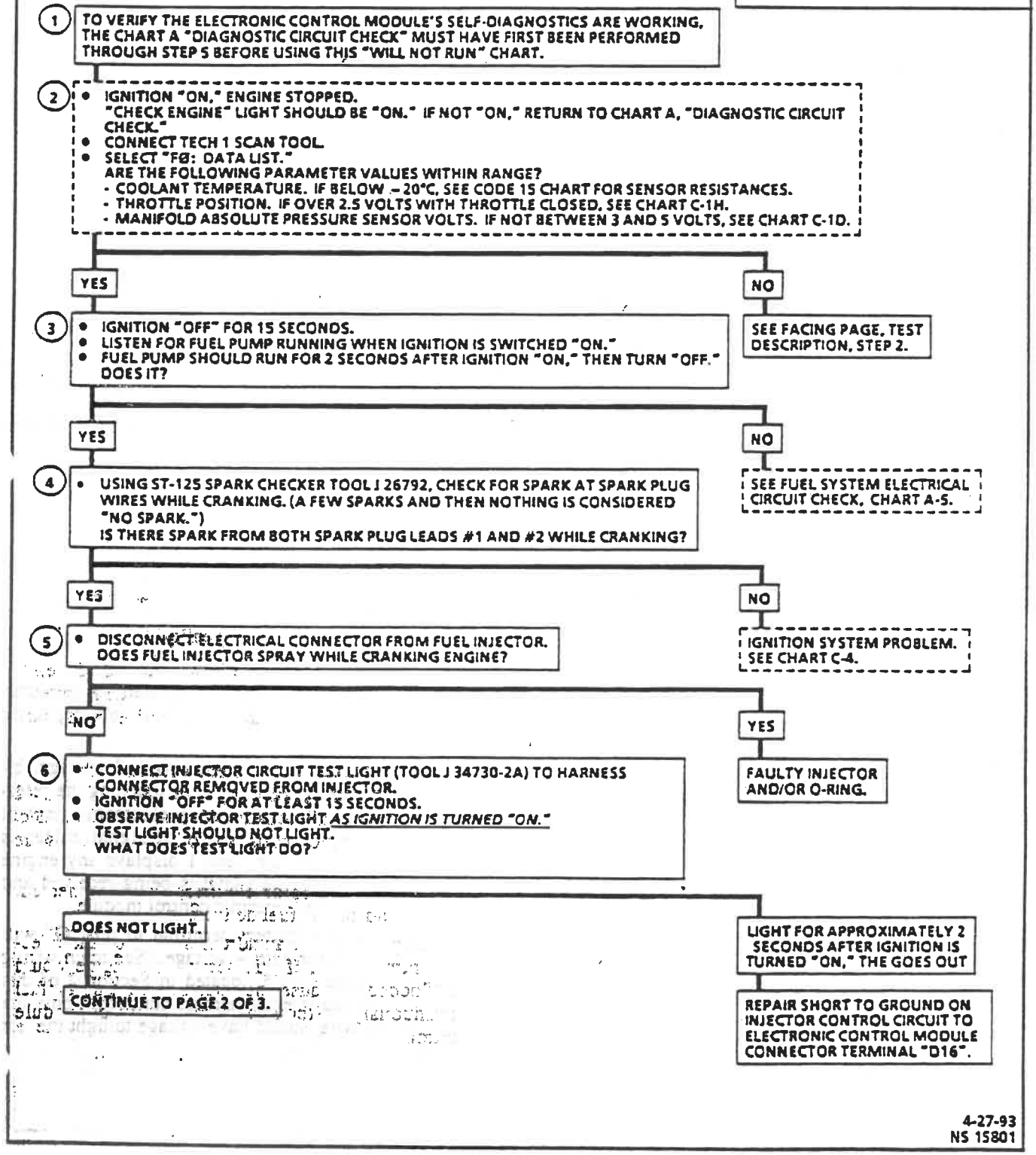
1. It is essential that CHART A, "Diagnostic Circuit Check" be performed first. CHART A will determine if:
   - Electronic control module power and ground circuits are OK.
   - Electronic control module self diagnostic ability is operating.
   - Tech 1 "Scan" tool can communicate with the electronic control module.
2. If incorrect, these sensor input signals to the electronic control module can cause a no-start.
3. Any time the electronic control module has been "OFF" for at least 15 seconds, it energizes the fuel pump relay for 2 seconds after the ignition switch is turned "ON." If the engine is not cranked, the electronic control module turns the relay "OFF" after 2 seconds. Have an assistant listen for fuel pump running at the rear of vehicle.
4. This step checks for sufficient voltage at the spark plug end of the spark plug wire. Wire #1 and #2 must be tested individually. Wire #1 and #2 connect to different ignition coils, so both ignition coils are checked.
5. With the fuel injector electrically disconnected, there should be NO fuel delivered.
6. This step checks for a short to ground on the injector control circuit. If this occurs, the engine would be "flooded" because the injector would spray fuel continuously, without electronic control module control.

CHART A-3

(Page 1 of 3)

ENGINE CRANKS BUT WILL NOT RUN

1.7L THROTTLE BODY INJECTION NIVA


1
TO VERIFY THE ELECTRONIC CONTROL MODULE'S SELF-DIAGNOSTICS ARE WORKING, THE CHART A "DIAGNOSTIC CIRCUIT CHECK" MUST HAVE FIRST BEEN PERFORMED THROUGH STEP 5 BEFORE USING THIS "WILL NOT RUN" CHART.
2
• IGNITION "ON," ENGINE STOPPED. "CHECK ENGINE" LIGHT SHOULD BE "ON." IF NOT "ON," RETURN TO CHART A, "DIAGNOSTIC CIRCUIT CHECK."
• CONNECT TECH 1 SCAN TOOL
• SELECT "FØ: DATA LIST."
ARE THE FOLLOWING PARAMETER VALUES WITHIN RANGE?
- COOLANT TEMPERATURE. IF BELOW –20°C, SEE CODE 15 CHART FOR SENSOR RESISTANCES.
- THROTTLE POSITION. IF OVER 2.5 VOLTS WITH THROTTLE CLOSED, SEE CHART C-1H.
- MANIFOLD ABSOLUTE PRESSURE SENSOR VOLTS. IF NOT BETWEEN 3 AND 5 VOLTS, SEE CHART C-1D.
YES
NO
SEE FACING PAGE, TEST DESCRIPTION, STEP 2.
3
• IGNITION "OFF" FOR 15 SECONDS.
• LISTEN FOR FUEL PUMP RUNNING WHEN IGNITION IS SWITCHED "ON."
• FUEL PUMP SHOULD RUN FOR 2 SECONDS AFTER IGNITION "ON," THEN TURN "OFF." DOES IT?
YES
NO
SEE FUEL SYSTEM ELECTRICAL CIRCUIT CHECK, CHART A-5.
4
• USING ST-125 SPARK CHECKER TOOL J 26792, CHECK FOR SPARK AT SPARK PLUG WIRES WHILE CRANKING. (A FEW SPARKS AND THEN NOTHING IS CONSIDERED "NO SPARK.")
IS THERE SPARK FROM BOTH SPARK PLUG LEADS #1 AND #2 WHILE CRANKING?
YES
NO
IGNITION SYSTEM PROBLEM. SEE CHART C-4.
5
• DISCONNECT ELECTRICAL CONNECTOR FROM FUEL INJECTOR. DOES FUEL INJECTOR SPRAY WHILE CRANKING ENGINE?
NO
YES
FAULTY INJECTOR AND/OR O-RING.
6
• CONNECT INJECTOR CIRCUIT TEST LIGHT (TOOL J 34730-2A) TO HARNESS CONNECTOR REMOVED FROM INJECTOR.
• IGNITION "OFF" FOR AT LEAST 15 SECONDS.
• OBSERVE INJECTOR TEST LIGHT AS IGNITION IS TURNED "ON."
TEST LIGHT SHOULD NOT LIGHT.
WHAT DOES TEST LIGHT DO?
DOES NOT LIGHT.
CONTINUE TO PAGE 2 OF 3.
LIGHT FOR APPROXIMATELY 2 SECONDS AFTER IGNITION IS TURNED "ON," THE GOES OUT
REPAIR SHORT TO GROUND ON INJECTOR CONTROL CIRCUIT TO ELECTRONIC CONTROL MODULE CONNECTOR TERMINAL "D16".

4-27-93
NS 15801

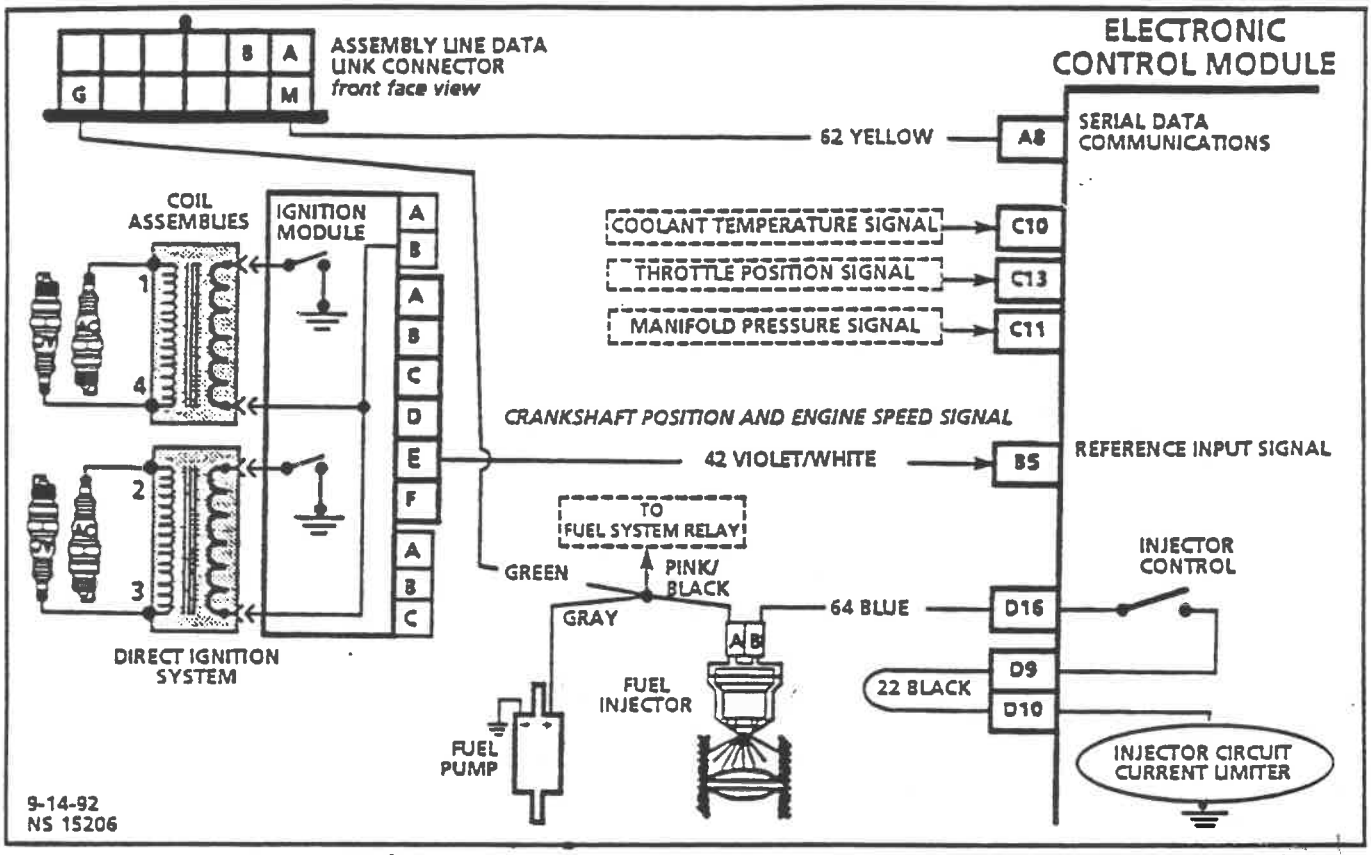


CHART A-3

(Page 2 of 3)

ENGINE CRANKS BUT WILL NOT RUN
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

Before using this chart check: battery condition, engine cranking speed, fuel quantity and quality.

Test Description: Numbers (s) below refer to circled number(s) on the diagnostic chart.

7. The electronic control module normally provides electrical pulses (to ground) to operate the fuel injector. This step checks for these electrical pulses while cranking.
8. This step checks for fuel spray when the injector receives the electrical pulses verified in Step 7. If there is fuel spray, see the next (bottom) box for possible causes of a "WILL NOT RUN."
9. Incorrect fuel pressure can cause a "WILL NOT RUN." If fuel pressure is OK, the injector is faulty.
10. The electronic control module must receive "reference signal input" pulses from the ignition system, to calculate any "engine running" functions. The Tech 1 will show the engine speed if the electronic control module is receiving this reference signal.

NOTICE: If engine speed is indicated but less than 80, check for and repair cause of low cranking speed.

11. With the test light connected to "+" voltage, by quickly, repeatedly, momentarily touching the reference signal wire going to the electronic control module a "substitute" source of signal pulses is being generated. If the Tech 1 displays any engine speed above zero, the signal is being received and interpreted by the electronic control module.
12. Jumpering the + battery terminal to pin "G" will power the injector with + voltage. (See main wiring diagrams, page 2 of 5, located in Section 2 of this manual.) At the injector harness connector, only the Pink/Black wire should have voltage to light the test light.

CHART A-3

(Page 2 of 3)

ENGINE CRANKS BUT WILL NOT RUN

1.7L THROTTLE BODY INJECTION NIVA

CONTINUED FROM PAGE 1 OF 3

(7) • WATCH INJECTOR TEST LIGHT WHILE CRANKING THE ENGINE.
DOES TEST LIGHT BLINK?

NO

YES

(8) • REMOVE INJECTOR TEST LIGHT FROM HARNESS CONNECTOR.
• RECONNECT HARNESS CONNECTOR TO INJECTOR.
• LOOK FOR FUEL SPRAY FROM INJECTOR.
DOES FUEL SPRAY WHILE CRANKING ENGINE?

YES

- CHECK FOR:
  - FOULED SPARK PLUGS.
  - RESTRICTED EXHAUST SYSTEM. REFER TO CHART B-1.
  - INCORRECT FUEL OR WATER/FOREIGN MATERIAL IN FUEL.
  - SPARK PLUG WIRES "CROSSED." CONNECTED INTO WRONG SPARK PLUGS.
  - INCORRECT FUEL PRESSURE. REFER TO CHART A-7.
  - CAMSHAFT TIMING CHAIN SLIPPED OR STRIPPED.
  - INADEQUATE ENGINE COMPRESSION.

(9) NO

- IGNITION "OFF."
- INSTALL FUEL PRESSURE GAGE. (SEE CHART A-7 TO DETERMINE WHERE TO CONNECT FUEL PRESSURE GAGE).
- IGNITION "ON."
- FUEL PRESSURE SHOULD BE 190 TO 210 kPa (27.6 TO 30.5 PSI, 1.9 - 2.1 BAR).
IS IT?

YES

FAULTY INJECTOR. CHECK FOR SHORT TO GROUND IN ELECTRONIC CONTROL MODULE TERMINAL "D9" AND "D10" CIRCUIT.

NO

REFER TO "FUEL SYSTEM DIAGNOSIS," CHART A-7.

(10) • INSTALL TECH 1. SELECT "F0: DATA LIST."
• MONITOR "ENGINE SPEED" WHILE HOLDING THE IGNITION SWITCH KEY IN THE "START" POSITION.
IS ENGINE SPEED INDICATING MORE THAN 80 WHILE CRANKING?

YES

(12) • DISCONNECT TECH 1 SCAN TOOL.
• WITH A FUSED JUMPER WIRE, JUMPER THE " + " BATTERY TERMINAL TO PIN "G" OF THE ASSEMBLY LINE DATA LINK CONNECTOR.
• IGNITION "ON," DISCONNECT FUEL INJECTOR.
• WITH A TEST LIGHT CONNECTED TO GROUND, TOUCH EACH OF THE 2 TERMINALS OF THE DISCONNECTED INJECTOR HARNESS CONNECTOR.
• OBSERVE TEST LIGHT ON EACH TERMINAL

(11) NO

- DISCONNECT 6 PIN HARNESS CONNECTOR FROM IGNITION MODULE.
- IGNITION "ON."
- CONNECT TEST LIGHT CLIP LEAD TO " + " BATTERY TERMINAL.
- OBSERVE TECH 1 "ENGINE SPEED" WHILE USING TEST LIGHT TO QUICKLY AND REPEATEDLY TOUCH TERMINAL "E" OF 6 PIN HARNESS CONNECTOR REMOVED FROM IGNITION MODULE.
- TECH 1 SHOULD INDICATE AN ENGINE SPEED ABOVE ZERO.
DOES IT?

YES

FAULTY CONNECTION OR DEFECTIVE IGNITION MODULE.

NO

PROBLEM IS EITHER A CIRCUIT FAULT ON THE "REFERENCE INPUT SIGNAL" VIOLET/WHITE WIRE BETWEEN 6 PIN IGNITION MODULE CONNECTOR TERMINAL "E" TO ELECTRONIC CONTROL MODULE TERMINAL "B5", OR A DEFECTIVE ELECTRONIC CONTROL MODULE. VERIFY THAT NO CIRCUIT FAULT (OPEN, SHORT TO GROUND, SHORT TO VOLTAGE) IS PRESENT BEFORE REPLACING ELECTRONIC CONTROL MODULE.

LIGHT "ON" ONE TERMINAL ONLY

DISCONNECT FUSED JUMPER WIRE FROM DATA LINK CONNECTOR

NO LIGHT EITHER TERMINAL

REPAIR OPEN CIRCUIT IN PINK/BLACK "POWER SUPPLY" WIRE TO INJECTOR.

LIGHT "ON," BOTH TERMINALS

REPAIR SHORT TO VOLTAGE ON BLUE "INJECTOR CONTROL CIRCUIT" WIRE.

4-27-93
NS 14404

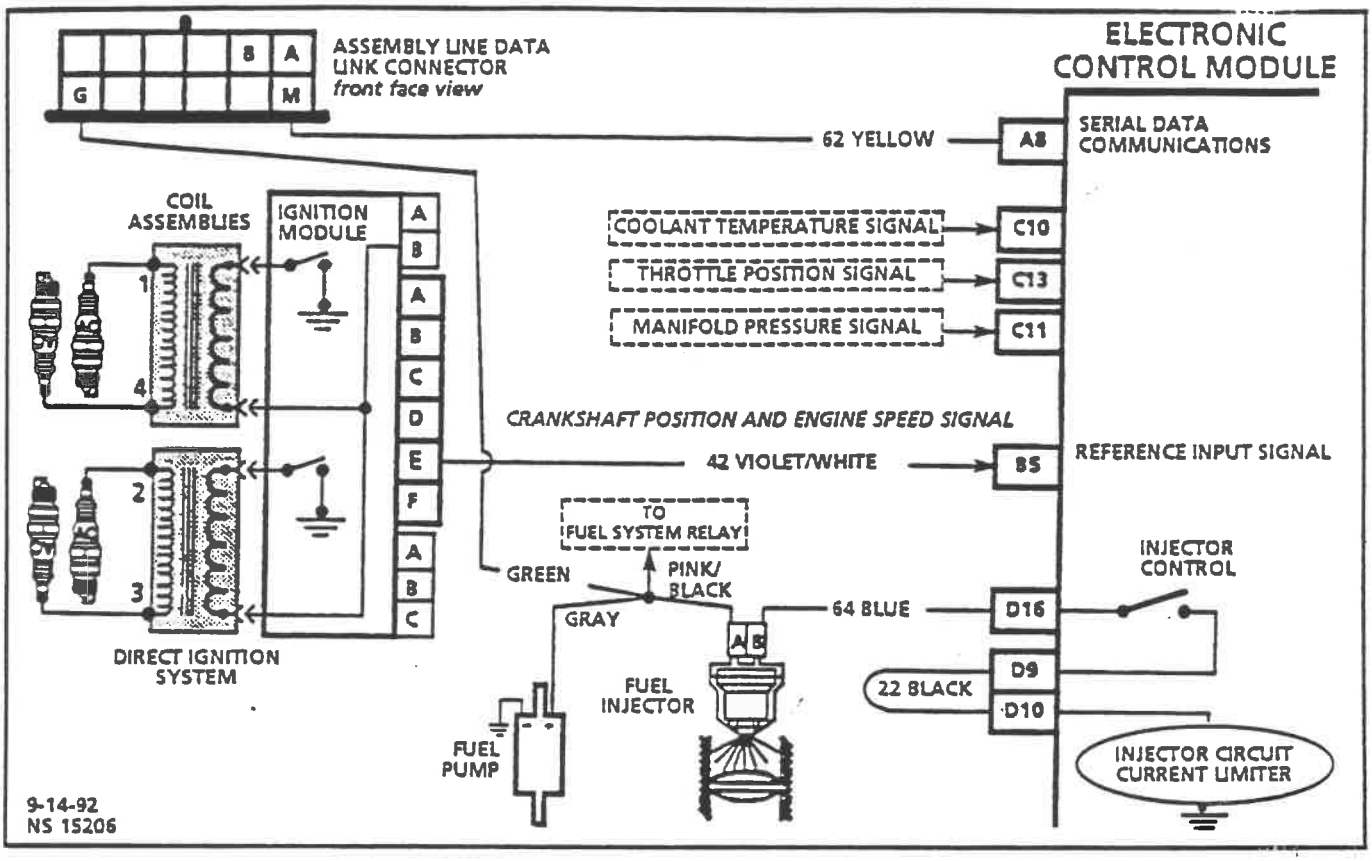


CHART A-3

(Page 3 of 3)
ENGINE CRANKS BUT WILL NOT RUN
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

Before using this chart check: battery condition, engine cranking speed, fuel quantity and quality.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

13. If the engine is too cold or too hot to properly test the fuel injector, the test results would be invalid. It is imperative for accurate test results that the injector temperature is between 10°C and 35°C.
14. This test uses the fuel injector tester J 39021 and the digital voltmeter J 39689 together. The injector tester supplies one of three fixed amperage current values throughout the duration of the test. Selection of the correct supply amperage value of 4 amps is based on the injector coil's specified resistance when the push-to-test button is depressed. The tester energizes the injector solenoid coil for 5 seconds.

    The condition of the injector solenoid coil is determined by the voltage displayed on the digital voltmeter *while the injector is energized.* The voltage reading displayed during the first second of the five second test should be ignored.
15. This step checks that the injector control circuit (Blue #64 wire) is a complete circuit to the electronic control module. With the injector connected, the voltage from the Pink/Blue injector wire goes through the injector, and through the Blue #64 wire to the electronic control module terminal "D16".
16. Electronic control module terminals "D9" and "D10" are connected by a loop of wire in the harness. If this loop breaks open, the injector control circuits inside the electronic control module damage could result. If circuit is shorted to voltage (+12 volts), the engine will not start.

CHART A-3
(Page 3 of 3)
ENGINE CRANKS BUT WILL NOT RUN
1.7L THROTTLE BODY INJECTION NIVA

FROM CHART A-3 PAGE 2 OF 3

FUEL INJECTOR TEST TO BE PERFORMED NEXT, WITH ENGINE TEMPERATURE BETWEEN 10°C AND 35°C FOR ACCURATE INJECTOR TEST.

(13)
- IGNITION "ON".
- CONNECT TECH 1. SELECT "FØ: DATA LIST". OBSERVE COOLANT TEMPERATURE.
- IS COOLANT TEMPERATURE BETWEEN 10°C AND 35°C?

NO → INJECTOR *MUST* BE TESTED AT TEMPERATURES BETWEEN 10°C AND 35°C. ALLOW THE ENGINE TO WARM OR COOL AS NEEDED.

YES

- IGNITION "OFF".
- CONNECT FUEL INJECTOR TESTER J-39021 POWER CABLE TO VEHICLE BATTERY. SET THE TESTER ROTARY SWITCH TO THE "INJECTOR COIL TEST, 4 AMP" POSITION.
- PLUG DIGITAL VOLTMETER J-39689 TEST LEADS (+ / −) INTO FUEL INJECTOR TESTER. SET THE DIGITAL VOLTMETER TO MEASURE "DC VOLTS."
- DISCONNECT HARNESS CONNECTOR FROM FUEL INJECTOR. USING TESTER ADAPTOR J-39021-30, CONNECT FUEL INJECTOR TESTER CABLE TO FUEL INJECTOR.
- FUEL INJECTOR TESTER "LOW VEHICLE BATTERY" INDICATOR SHOULD *NOT* BE "ON". IS IT?

YES → CHARGE VEHICLE BATTERY BEFORE PROCEEDING.

NO

(14)
- OBSERVE VOLTMETER, AS INJECTOR TESTER "START TEST" BUTTON IS PUSHED ONCE. (INJECTOR WILL AUTOMATICALLY BE TESTED FOR 5 SECONDS. DO NOT TEST MORE OFTEN THAN ONCE PER MINUTE)
- VOLTAGE DISPLAYED SHOULD STAY BETWEEN 5.4 AND 8.5 VOLTS DC. (DISREGARD FIRST SECOND OF THE 5-SECOND TEST.) DOES VOLTAGE STAY BETWEEN 5.4 AND 8.5 VOLTS?

NO → FAULTY FUEL INJECTOR.

YES

(15)
- DISCONNECT TESTERS, AND RECONNECT HARNESS TO FUEL INJECTOR.
- DISCONNECT ELECTRONIC CONTROL MODULE CONNECTORS.
- WITH A FUSED JUMPER WIRE, JUMPER THE " + " BATTERY TERMINAL TO PIN "G" OF THE DATA LINK CONNECTOR.
- BACKPROBE ELECTRONIC CONTROL MODULE HARNESS CONNECTOR "D16" WITH TEST LIGHT CONNECTED TO GROUND. IS TEST LIGHT "ON"?

NO → REPAIR OPEN CIRCUIT ON BLUE "INJECTOR CONTROL CIRCUIT" WIRE, BETWEEN INJECTOR HARNESS CONNECTOR AND ELECTRONIC CONTROL MODULE TERMINAL "D16".

YES

(16)
- REMOVE FUSED JUMPER WIRE FROM DATA LINK CONNECTOR.
- USING A DIGITAL MULTIMETER J 39689, CHECK THE RESISTANCE BETWEEN THE ELECTRONIC CONTROL MODULE HARNESS CONNECTOR TERMINALS "D9" AND "D10". RESISTANCE SHOULD BE LESS THAN 1 OHM. IS IT?

YES → FAULTY CONNECTIONS, OR FAULTY ELECTRONIC CONTROL MODULE.

NO

REPAIR OPEN CIRCUIT IN THE WIRE LOOP, BETWEEN ELECTRONIC CONTROL MODULE HARNESS CONNECTOR TERMINAL "D9" TO "D10".

2-8-93
NS 15803

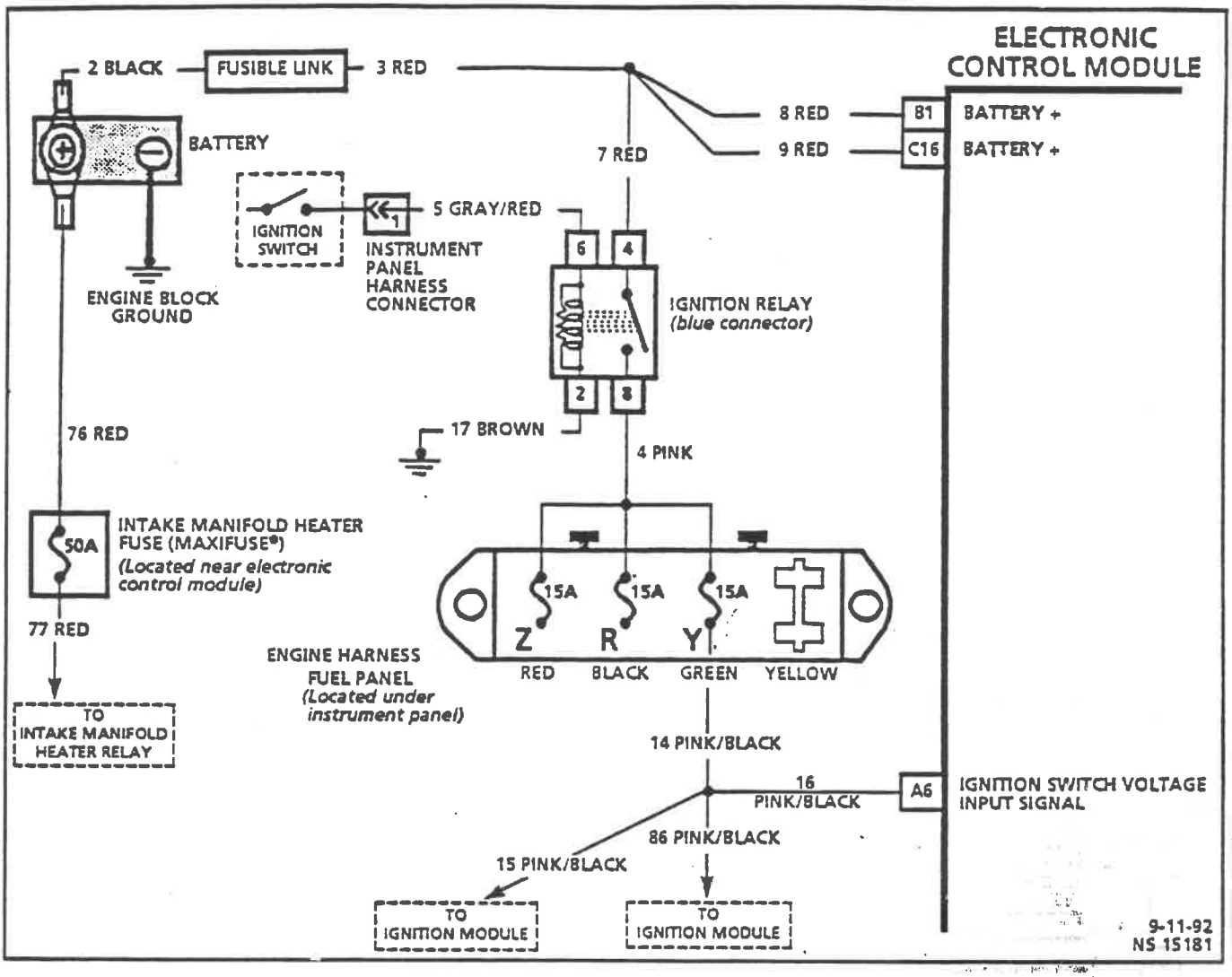


CHART A-4

(Page 1 of 2)

IGNITION RELAY AND POWER CIRCUITS CHECK 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

When the ignition switch is turned "ON," it activates the ignition relay and supplies voltage to the electronic control module. The electronic control module will operate as long as voltage is applied to electronic control module terminal "A6" ignition switch voltage input signal during cranking or running. The electronic control module terminals "B1" and "C16" receive power directly from the battery, through a fusible link.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Power is supplied from the battery through a fusible link, directly to both terminals "B1" and "C16" of the electronic control module.
2. If the ignition relay and the wiring that supplies power to terminal "A6" are okay, the testlight should light.
3. Battery voltage should be available at the ignition relay's blue connector, terminal "4" and "6". (These are gray/red wire and the Red wire terminals.) If power is available at both terminals, the testlight should light when touched to each of the two relay terminals.

Diagnostic Aids:

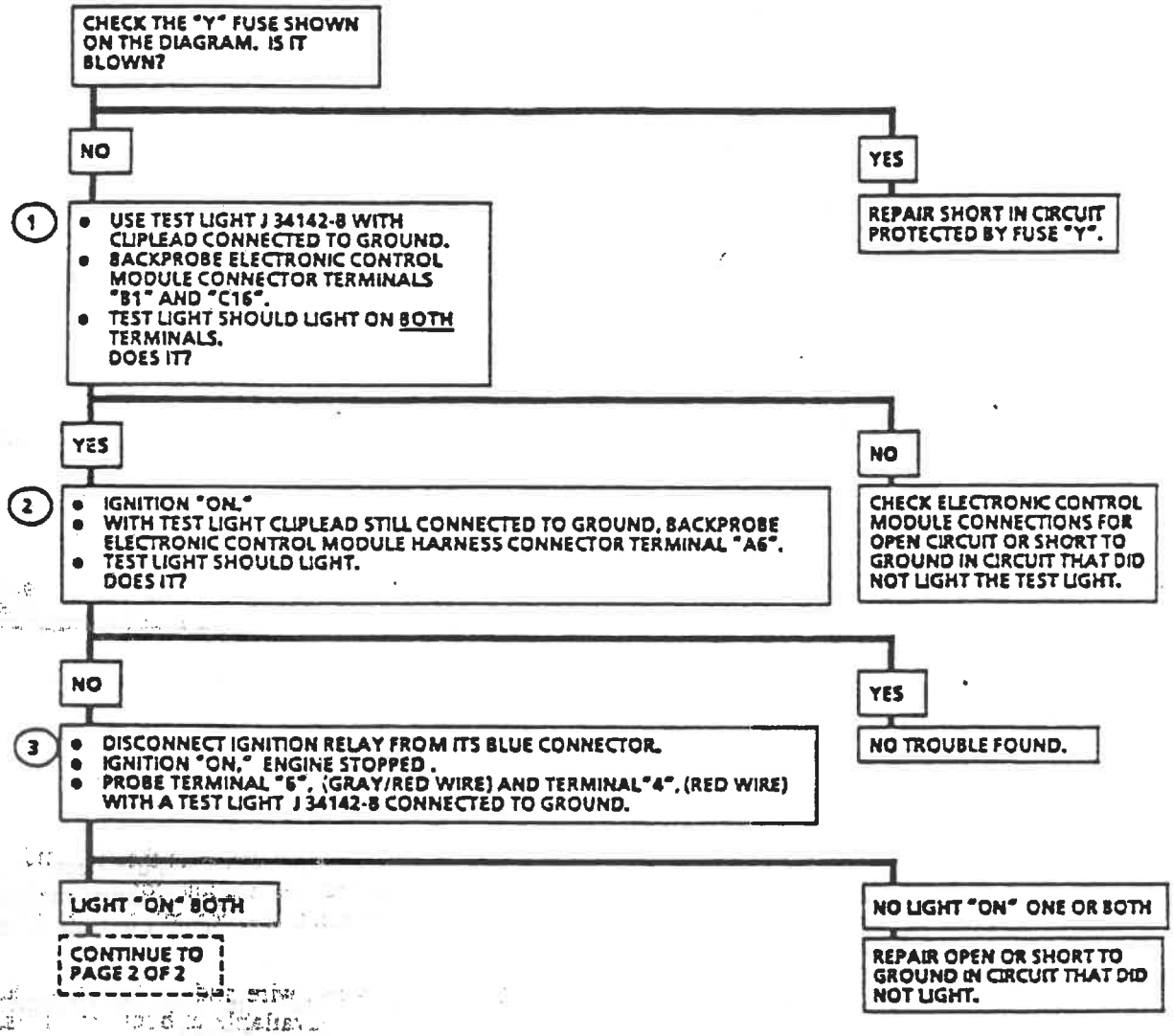
The intake manifold heater relay is the same as the ignition relay. If the ignition relay fails the intake manifold heater relay can be used to operate the vehicle until a replacement relay can be obtained.

CHART A-4

(Page 1 of 2)

IGNITION RELAY AND POWER CIRCUITS CHECK

1.7L THROTTLE BODY INJECTION NIVA


CHECK THE "Y" FUSE SHOWN ON THE DIAGRAM. IS IT BLOWN?
NO
YES
REPAIR SHORT IN CIRCUIT PROTECTED BY FUSE "Y".
1
• USE TEST LIGHT J 34142-B WITH CLIPLEAD CONNECTED TO GROUND.
• BACKPROBE ELECTRONIC CONTROL MODULE CONNECTOR TERMINALS "B1" AND "C16".
• TEST LIGHT SHOULD LIGHT ON BOTH TERMINALS.
DOES IT?
YES
NO
2
• IGNITION "ON."
• WITH TEST LIGHT CLIPLEAD STILL CONNECTED TO GROUND, BACKPROBE ELECTRONIC CONTROL MODULE HARNESS CONNECTOR TERMINAL "A6".
• TEST LIGHT SHOULD LIGHT.
DOES IT?
CHECK ELECTRONIC CONTROL MODULE CONNECTIONS FOR OPEN CIRCUIT OR SHORT TO GROUND IN CIRCUIT THAT DID NOT LIGHT THE TEST LIGHT.
NO
YES
3
• DISCONNECT IGNITION RELAY FROM ITS BLUE CONNECTOR.
• IGNITION "ON," ENGINE STOPPED.
• PROBE TERMINAL "6", (GRAY/RED WIRE) AND TERMINAL "4", (RED WIRE) WITH A TEST LIGHT J 34142-B CONNECTED TO GROUND.
NO TROUBLE FOUND.
LIGHT "ON" BOTH
NO LIGHT "ON" ONE OR BOTH
CONTINUE TO PAGE 2 OF 2
REPAIR OPEN OR SHORT TO GROUND IN CIRCUIT THAT DID NOT LIGHT.

9-22-92
NS 15802

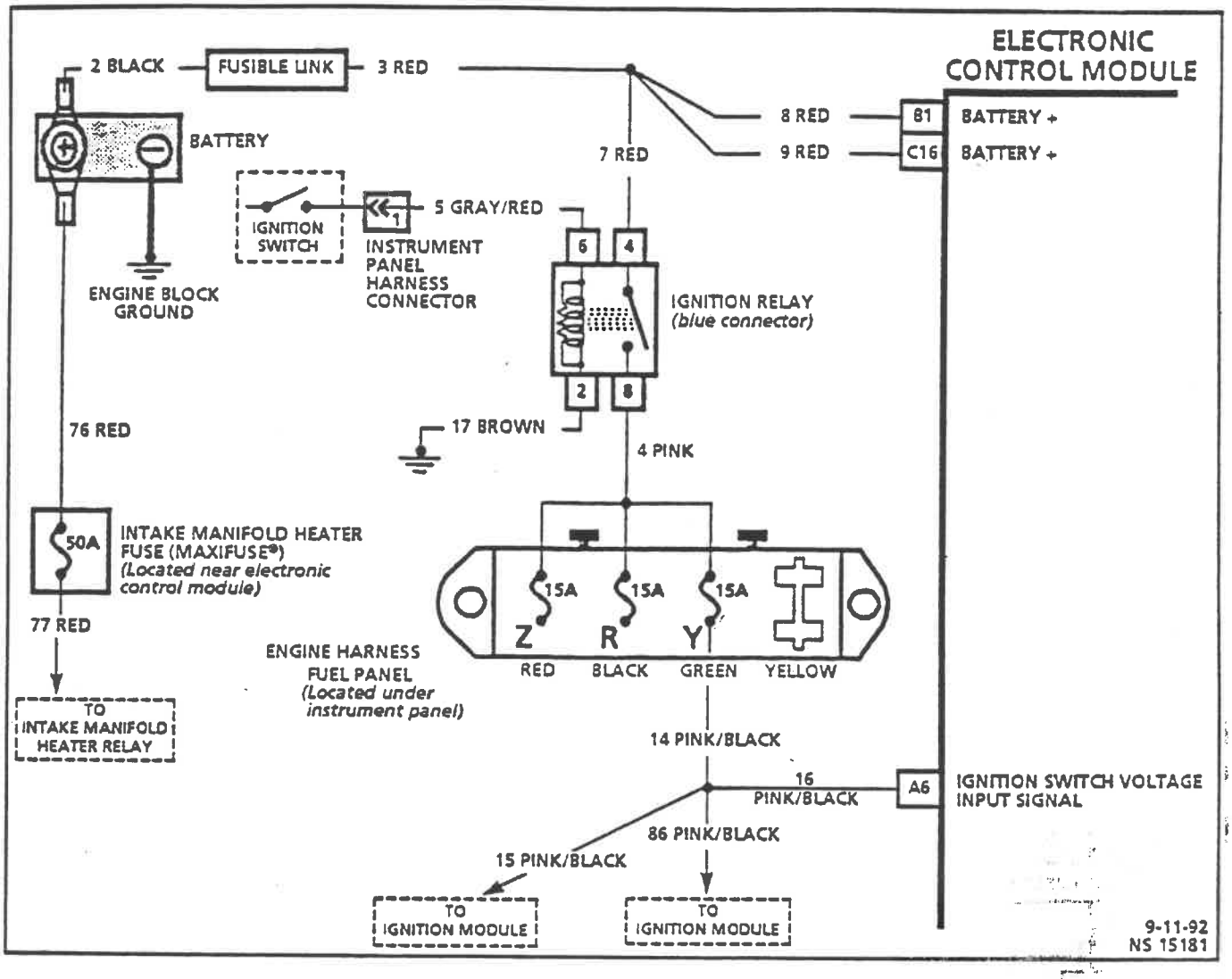


CHART A-4

(Page 2 of 2)

IGNITION RELAY AND POWER CIRCUITS CHECK 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

When the ignition switch is turned "ON," it activates the ignition relay and supplies voltage to the electronic control module. The electronic control module will operate as long as voltage is applied to electronic control module terminal "A6" ignition switch voltage input signal during cranking or running. The electronic control module terminals "B1" and "C16" receive power directly from the battery, through a fusible link.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

4. A previous test proved that power was available at the relay connector, terminal "6" (Gray/Red wire). This test will check if the Brown wire to relay terminal "2" is a good ground circuit.
5. This test checks the switch portion of the relay. The Tech 1 "Scan" tool displays "system voltage" from the electronic control module's interpretation of the voltage level at terminal "A6".
6. This checks the Pink wire, from the ignition relay blue connector to the fuse block.

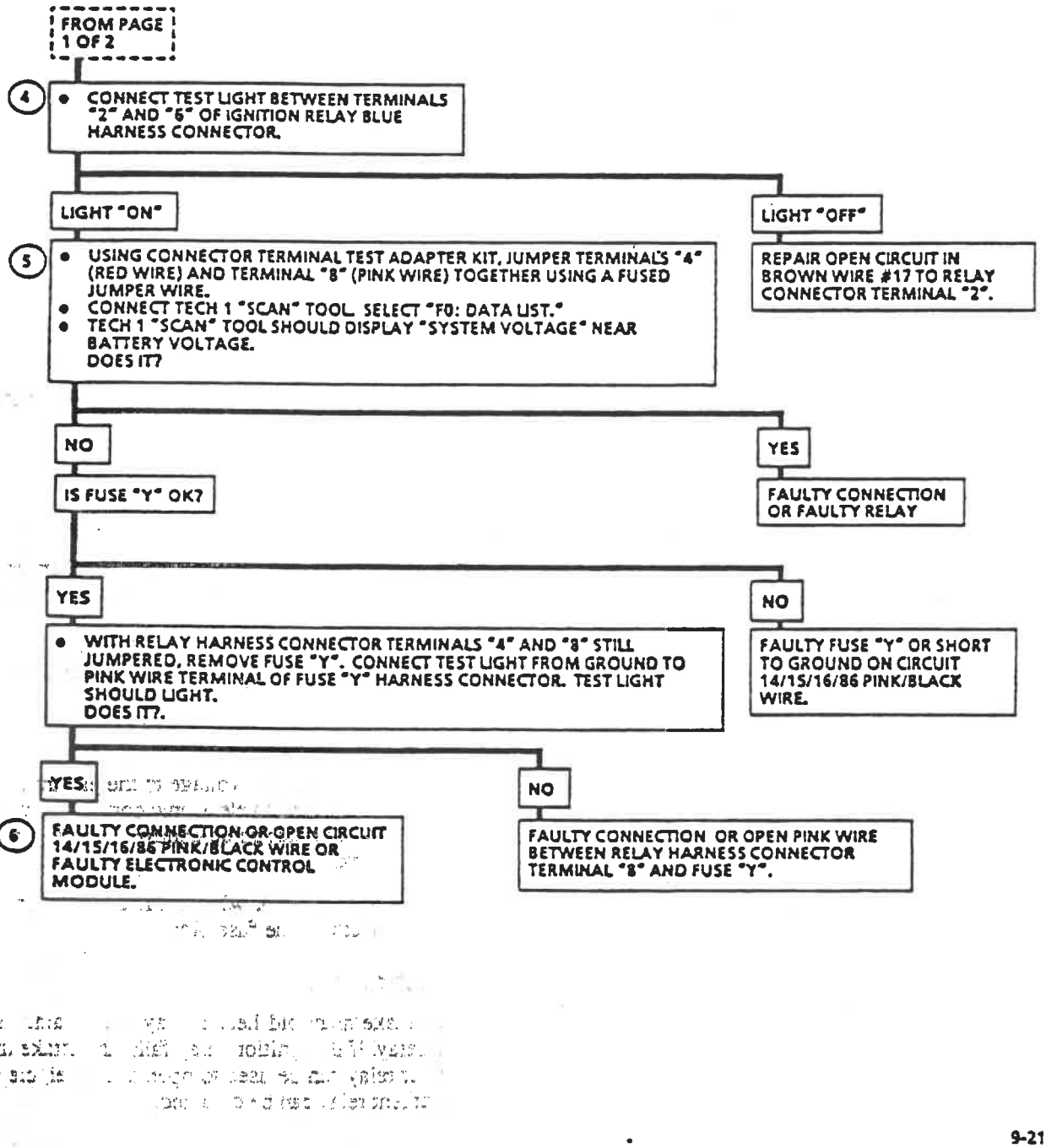
Diagnostic Aids:

The intake manifold heater relay is the same as the ignition relay. If the ignition relay fails, the intake manifold heater relay can be used to operate the vehicle until a replacement relay can be obtained.

CHART A-4

(Page 2 of 2)

IGNITION RELAY AND POWER CIRCUITS CHECK 1.7L THROTTLE BODY INJECTION NIVA


FROM PAGE 1 OF 2
4
• CONNECT TEST LIGHT BETWEEN TERMINALS "2" AND "6" OF IGNITION RELAY BLUE HARNESS CONNECTOR.
LIGHT "ON"
LIGHT "OFF"
REPAIR OPEN CIRCUIT IN BROWN WIRE #17 TO RELAY CONNECTOR TERMINAL "2".
5
• USING CONNECTOR TERMINAL TEST ADAPTER KIT, JUMPER TERMINALS "4" (RED WIRE) AND TERMINAL "8" (PINK WIRE) TOGETHER USING A FUSED JUMPER WIRE.
• CONNECT TECH 1 "SCAN" TOOL. SELECT "F0: DATA LIST."
• TECH 1 "SCAN" TOOL SHOULD DISPLAY "SYSTEM VOLTAGE" NEAR BATTERY VOLTAGE.
DOES IT?
NO
YES
IS FUSE "Y" OK?
FAULTY CONNECTION OR FAULTY RELAY
YES
NO
• WITH RELAY HARNESS CONNECTOR TERMINALS "4" AND "8" STILL JUMPERED, REMOVE FUSE "Y". CONNECT TEST LIGHT FROM GROUND TO PINK WIRE TERMINAL OF FUSE "Y" HARNESS CONNECTOR. TEST LIGHT SHOULD LIGHT.
DOES IT?
FAULTY FUSE "Y" OR SHORT TO GROUND ON CIRCUIT 14/15/16/86 PINK/BLACK WIRE.
YES
NO
6
FAULTY CONNECTION OR OPEN CIRCUIT 14/15/16/86 PINK/BLACK WIRE OR FAULTY ELECTRONIC CONTROL MODULE.
FAULTY CONNECTION OR OPEN PINK WIRE BETWEEN RELAY HARNESS CONNECTOR TERMINAL "8" AND FUSE "Y".

9-21-92
NS 15210

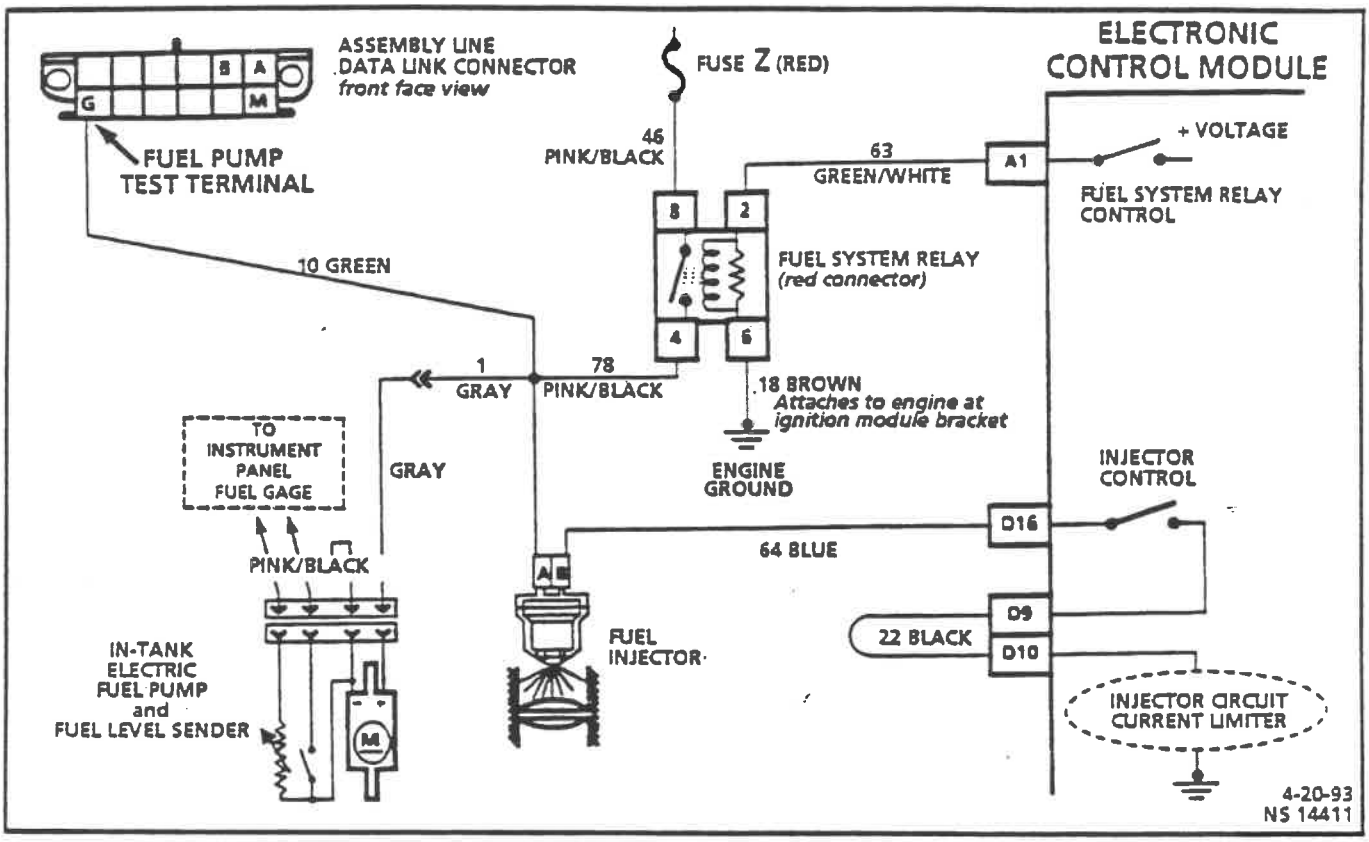


CHART A-5

FUEL SYSTEM ELECTRICAL CIRCUIT CHECK
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

When the ignition switch is turned "ON," the electronic control module will activate the fuel pump relay and run the in-tank fuel pump. The fuel pump will operate as long as the engine is cranking or running, and the electronic control module is receiving ignition reference pulses.

If there are no reference pulses, the electronic control module will shut "OFF" the fuel pump within 2 seconds after ignition "ON."

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. The fuel system relay as described above can be energized by turning the ignition key to the "ON" position, after it has been "OFF" for at least 15 seconds. The fuel pump should run for 2 seconds and then turn "OFF" as described above. To reenergize the pump turn the key to the "OFF" position for 10 seconds, then turn it to the "ON" position again.

CHART A-5

FUEL SYSTEM ELECTRICAL CIRCUIT CHECK 1.7L THROTTLE BODY INJECTION NIVA

①
- IGNITION MUST BE "OFF" FOR AT LEAST 15 SECONDS.
- ENABLE FUEL SYSTEM BY TURNING IGNITION KEY TO "ON" POSITION.
- LISTEN FOR RUNNING FUEL PUMP AT REAR OF VEHICLE.
- FUEL PUMP SHOULD RUN FOR 2 SECONDS AFTER IGNITION "ON."

DOES IT?

NO

- DISCONNECT FUEL SYSTEM RELAY.
- IGNITION "ON," ENGINE NOT RUNNING.
- PROBE RELAY HARNESS CONNECTOR TERMINAL "8" WITH A TEST LIGHT J 34142-B CONNECTED TO GROUND.

LIGHT "ON"

CONNECT A TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS "6" AND "8".

①
- CONNECT TEST LIGHT BETWEEN TERMINAL "2" AND GROUND.
- ENERGIZE THE FUEL SYSTEM RELAY AS DESCRIBED IN STEP ① ABOVE.
- TEST LIGHT SHOULD BE "ON" FOR 2 SECONDS.

LIGHT "ON"

①
- IGNITION "ON."
- RECONNECT FUEL SYSTEM RELAY.
- BACKPROBE RELAY TO CONNECT TEST LIGHT BETWEEN TERMINAL "4" AND GROUND.
- ENERGIZE THE FUEL SYSTEM RELAY AS DESCRIBED IN STEP ① ABOVE.
- TEST LIGHT SHOULD BE "ON" FOR 2 SECONDS.

LIGHT "ON"

①
- CONNECT TEST LIGHT BETWEEN FUEL PUMP TEST TERMINAL AND GROUND.
- ENERGIZE THE FUEL SYSTEM RELAY AS DESCRIBED IN STEP ① ABOVE.
- TEST LIGHT SHOULD BE "ON" FOR 2 SECONDS.

LIGHT "ON"

FAULTY CONNECTION
OR
OPEN CIRCUIT 1 GRAY WIRE
OR
FAULTY FUEL PUMP
OR
FAULTY FUEL PUMP GROUND

YES

FUEL SYSTEM RELAY CIRCUIT ELECTRICAL CHECK OK. SEE CHART A-7 FOR FUEL SYSTEM PRESSURE CHECK.

LIGHT "OFF"

FAULTY CONNECTION OR REPAIR OPEN IN CIRCUIT 46 PINK/BLACK WIRE FROM RELAY TERMINAL "8" TO FUSE "Z". IF FUSE "Z" IS BLOWN REPAIR SHORT TO GROUND IN FUEL PUMP CIRCUIT.

LIGHT "OFF"

FAULTY CONNECTION OR REPAIR OPEN GROUND CIRCUIT 18 BROWN WIRE AND BETWEEN FUEL PUMP AND ENGINE BLOCK GROUND RELAY TERMINAL "6".

LIGHT "OFF"

FAULTY CONNECTION OR CHECK FOR OPEN OR SHORT TO GROUND IN CIRCUIT 63 GREEN/WHITE WIRE FROM RELAY TERMINAL "2" TO ELECTRONIC CONTROL MODULE TERMINAL "A1". IF OK, IT'S A FAULTY ELECTRONIC CONTROL MODULE.

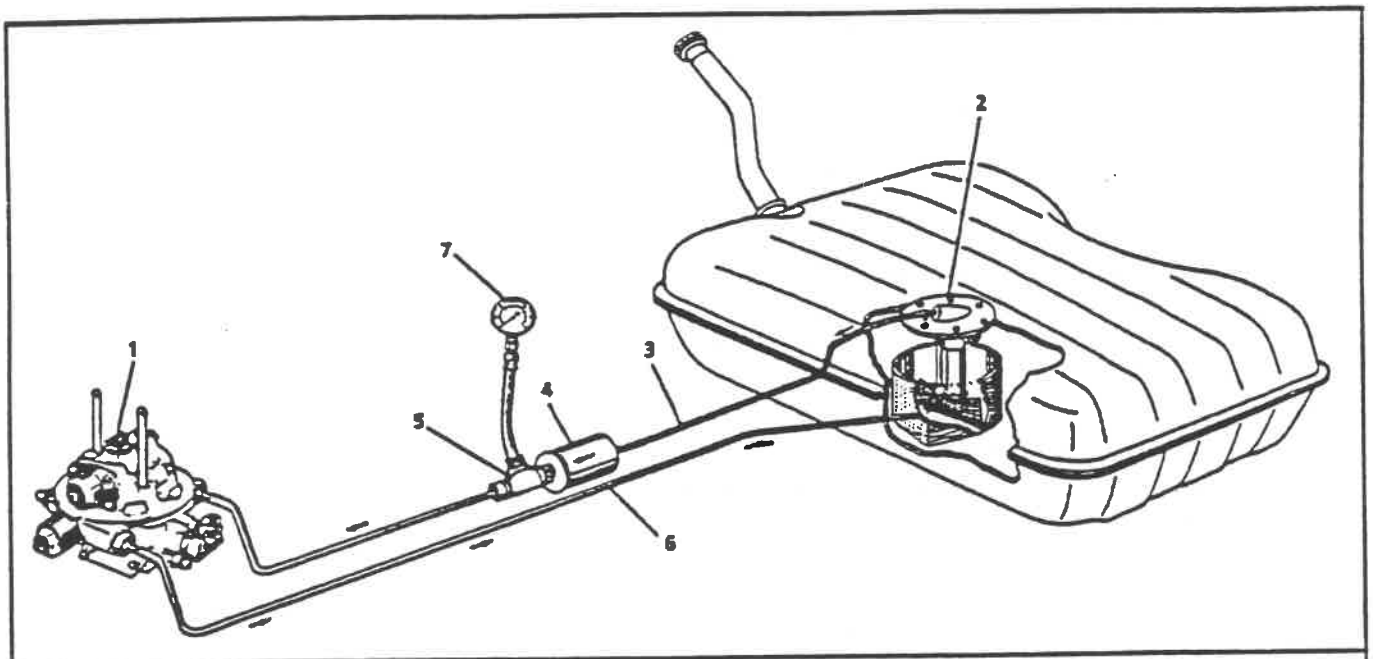
LIGHT "OFF"

FAULTY CONNECTION OR FAULTY FUEL SYSTEM RELAY.

LIGHT "OFF"

FAULTY CONNECTION
OR OPEN CIRCUIT 10 GREEN WIRE
OR OPEN CIRCUIT 78 PINK/GREEN WIRE

4-27-93
NS 14412



1 THROTTLE BODY INJECTION UNIT
2 FUEL PUMP
3 FUEL SUPPLY PRESSURE LINE
4 FUEL FILTER
5 FUEL PRESSURE TEST FITTING (PART OF TOOL J 38970-V)
6 FUEL RETURN LINE
7 FUEL PRESSURE GAUGE (PART OF TOOL J 28970-V)

NS 14683

CHART A-7

(Page 1 of 2)

FUEL SYSTEM DIAGNOSIS 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

When the ignition switch is turned "ON," the electronic control module will turn "ON" the fuel pump. It will remain "ON" as long as the engine is cranking or running, and the electronic control module is receiving crankshaft position pulses. If there are no reference pulses, the electronic control module will shut "OFF" the fuel pump within 2 seconds after key "ON."

The pump will deliver fuel to the throttle body injection unit, where the system pressure is controlled between 190 kPa (27.6 psi, 1.9 bar) and 210 kPa (30.5 psi, 2.1 bar). Excess fuel is then returned to the fuel tank.

The fuel pump test terminal (assembly line data link terminal "G") is located above and to the right of the driver's kick panel, above the electronic control module. When the engine is not running and the ignition switch is "OFF," the pump can be turned "ON" by applying battery voltage to the test terminal.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Checks for proper fuel pressure and system operation. By turning the ignition key to the "ON" position you will be able to energize the fuel system for 2 seconds at a time.
2. This step checks for leaks or loose connections between the fuel pressure test fitting and the throttle body injection unit. This step will also determine if the pressure regulator is operating properly.
3. This portion ensures no leaks or loose connections are present between the fuel pump and the fuel pressure test fitting. This step will also determine if the fuel pump is operating properly.

Diagnostic Aids:

Improper fuel system pressure can result in one of the following symptoms:

- Cranks, but will not run.
- Cuts out, may feel like ignition problem.
- Poor fuel economy, loss of power.
- Hesitation.

Have an assistant listen for fuel pump at rear of vehicle, pump may not be audible inside vehicle.

CHART A-7

(Page 1 of 2)

FUEL SYSTEM DIAGNOSIS 1.7L THROTTLE BODY INJECTION NIVA

1

- FUEL TANK HAS SUFFICIENT FUEL AND FUEL QUALITY IS OK.
- IGNITION "OFF," REMOVE FUEL TANK FILLER CAP TO RELIEVE ANY RESIDUAL TANK PRESSURE.
- DISCONNECT 4-TERMINAL ELECTRICAL CONNECTOR AT FUEL PUMP. (CONNECTOR ACCESS PANEL IS LOCATED IN FLOOR PAN DIRECTLY ABOVE FUEL TANK.)
- START ENGINE AND IDLE UNTIL ENGINE STALLS. ENGAGE STARTER FOR 3 SECONDS TO RELIEVE ANY REMAINING PRESSURE.
- DISCONNECT FUEL SUPPLY PRESSURE PIPE FROM FUEL FILTER "OUTLET" FITTING. INSTALL FUEL PRESSURE TEST FITTING TOOL J 38970-V BETWEEN FUEL FILTER OUTLET FITTING AND FUEL PIPE. (SEE FACING PAGE ILLUSTRATION.)
- INSTALL PRESSURE GAUGE J 38970-V ONTO FUEL PRESSURE TEST FITTING.
- IGNITION "OFF" FOR AT LEAST 15 SECONDS.
- OBSERVE FUEL PRESSURE AS IGNITION IS TURNED TO THE "ON" POSITION. THIS WILL CAUSE THE FUEL SYSTEM RELAY TO TURN "ON" FOR 2 SECONDS, THEN "OFF." DURING THE 2 SECONDS OF "ON" TIME THE FUEL PRESSURE SHOULD BE BETWEEN 190 kPa (27.6 psi, 1.9 bar) AND 210 kPa (30 psi, 2.1 bar).
  IS IT?

YES

NO

GO TO CHART A-7 PAGE 2 OF 2.

2

AFTER PUMP STOPS RUNNING, PRESSURE MAY DECREASE SLIGHTLY, THEN SHOULD HOLD STEADY WITH NO FURTHER DROP IN PRESSURE. (IF ENGINE IS WARM, A SLOW GRADUAL INCREASE IN PRESSURE IS NORMAL.) WHAT DOES PRESSURE DO?

PRESSURE CONTINUES TO DROP

PRESSURE HOLDS

NO TROUBLE FOUND

- IGNITION "OFF" FOR AT LEAST 15 SECONDS.
- AGAIN TURN THE IGNITION KEY "ON" TO ENERGIZE FUEL PUMP. IMMEDIATELY AFTER PUMP STOPS RUNNING, PINCH COMPLETELY SHUT A RUBBER SECTION OF FUEL HOSE BETWEEN FUEL PRESSURE TEST FITTING AND THROTTLE BODY INJECTION UNIT.
  DOES FUEL PRESSURE STABILIZE AND STOP DROPPING?

NO

YES

3

- IGNITION "OFF" FOR AT LEAST 15 SECONDS.
- AGAIN TURN THE IGNITION KEY "ON" TO ENERGIZE FUEL PUMP. IMMEDIATELY AFTER PUMP STOPS RUNNING, PINCH COMPLETELY SHUT A RUBBER SECTION OF FUEL HOSE BETWEEN FUEL PRESSURE TEST FITTING AND FUEL TANK. FUEL PRESSURE SHOULD STABILIZE AND STOP DROPPING.
  DOES IT?

- CHECK FOR LEAKS OR LOOSE CONNECTIONS BETWEEN THE FUEL PRESSURE TEST FITTING AND THE THROTTLE BODY INJECTION UNIT. MAKE THE SAME CHECK BETWEEN THE THROTTLE BODY INJECTION UNIT AND THE FUEL TANK.
- IF NO PROBLEMS ARE FOUND, REPLACE FUEL PRESSURE REGULATOR ON THE THROTTLE BODY INJECTION UNIT.

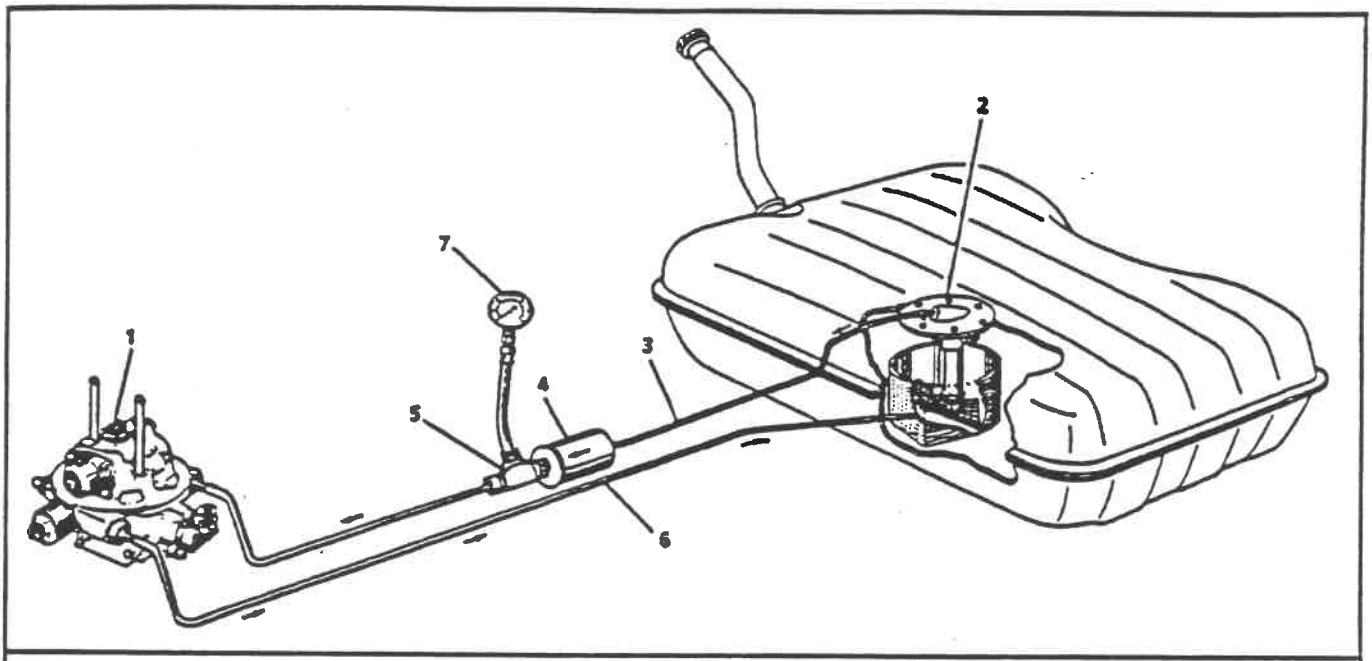
NO

YES

- GO THROUGH STEP 2, AGAIN MAKING SURE THERE ARE NO LEAKS OR LOOSE CONNECTIONS AS SPECIFIED ABOVE.

- CHECK FOR LEAKS OR LOOSE CONNECTIONS BETWEEN THE FUEL TANK AND THE FUEL PRESSURE TEST FITTING (THE SUPPLY LINE INCLUDING FUEL FILTER).
- IF NO PROBLEMS ARE FOUND REPLACE FUEL PUMP.

4-27-93
NS 14413



1 THROTTLE BODY INJECTION UNIT
2 FUEL PUMP
3 FUEL SUPPLY PRESSURE LINE
4 FUEL FILTER
5 FUEL PRESSURE TEST FITTING (PART OF TOOL J 38970-V)
6 FUEL RETURN LINE
7 FUEL PRESSURE GAUGE (PART OF TOOL J 28970-V)

NS 14683

CHART A-7

(Page 2 of 2)

FUEL SYSTEM DIAGNOSIS
1.7L THROTTLE BODY INJECTION NIVA

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

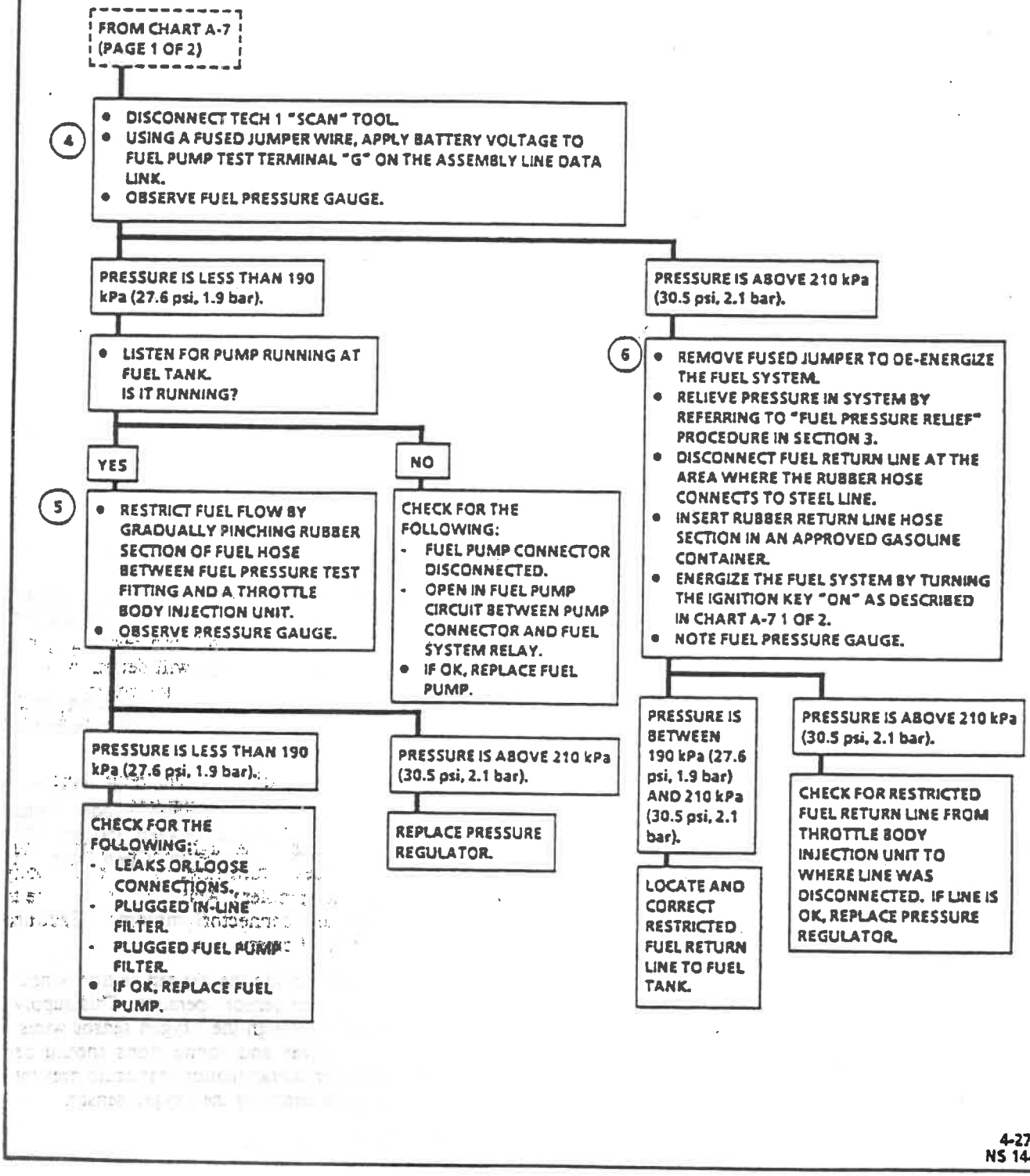
4. Fuel pressure less than 190 kPa (27.6 psi, 1.9 bar) falls into two areas:
   - Amount of fuel to injector is OK, but the pressure is less than 190 kPa (27.6 psi, 1.9 bar). Low fuel pressure can cause poor overall performance.
   - Restricted flow causing pressure drop. Normally, a vehicle with a fuel pressure of less than 190 kPa (27.6 psi, 1.9 bar) at idle will not be driveable. However, if the pressure drop occurs only while driving, the engine will surge, then stop, as pressure begins to drop rapidly.
5. Turning the fuel pump "ON" and restricting fuel flow at the fuel pressure gage will determine if the fuel pump can supply enough fuel pressure to the injector to operate properly, above 190 kPa (27.6 psi, 1.9 bar).

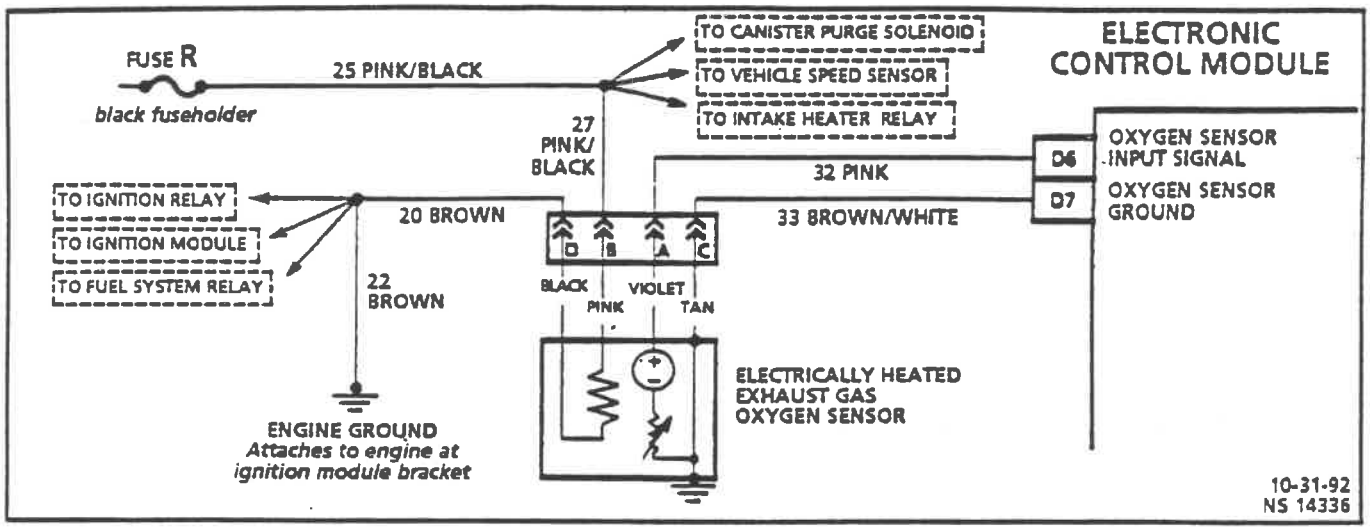
   NOTICE: Do not restrict the fuel return line, this may damage the fuel pressure regulator.
6. This test determines if the high fuel pressure is due to a restricted fuel return line, or a throttle body pressure regulator problem. Apply battery voltage to the fuel pump test connector only long enough to get an accurate fuel pressure reading.

CHART A-7

(Page 2 of 2)

FUEL SYSTEM DIAGNOSIS 1.7L THROTTLE BODY INJECTION NIVA


FROM CHART A-7 (PAGE 1 OF 2)
4
• DISCONNECT TECH 1 "SCAN" TOOL.
• USING A FUSED JUMPER WIRE, APPLY BATTERY VOLTAGE TO FUEL PUMP TEST TERMINAL "G" ON THE ASSEMBLY LINE DATA LINK.
• OBSERVE FUEL PRESSURE GAUGE.
PRESSURE IS LESS THAN 190 kPa (27.6 psi, 1.9 bar).
• LISTEN FOR PUMP RUNNING AT FUEL TANK. IS IT RUNNING?
YES
NO
5
• RESTRICT FUEL FLOW BY GRADUALLY PINCHING RUBBER SECTION OF FUEL HOSE BETWEEN FUEL PRESSURE TEST FITTING AND A THROTTLE BODY INJECTION UNIT.
• OBSERVE PRESSURE GAUGE.
CHECK FOR THE FOLLOWING:
- FUEL PUMP CONNECTOR DISCONNECTED.
- OPEN IN FUEL PUMP CIRCUIT BETWEEN PUMP CONNECTOR AND FUEL SYSTEM RELAY.
• IF OK, REPLACE FUEL PUMP.
PRESSURE IS LESS THAN 190 kPa (27.6 psi, 1.9 bar).
PRESSURE IS ABOVE 210 kPa (30.5 psi, 2.1 bar).
CHECK FOR THE FOLLOWING:
- LEAKS OR LOOSE CONNECTIONS.
- PLUGGED IN-LINE FILTER.
- PLUGGED FUEL PUMP FILTER.
• IF OK, REPLACE FUEL PUMP.
REPLACE PRESSURE REGULATOR.
PRESSURE IS ABOVE 210 kPa (30.5 psi, 2.1 bar).
6
• REMOVE FUSED JUMPER TO DE-ENERGIZE THE FUEL SYSTEM.
• RELIEVE PRESSURE IN SYSTEM BY REFERRING TO "FUEL PRESSURE RELIEF" PROCEDURE IN SECTION 3.
• DISCONNECT FUEL RETURN LINE AT THE AREA WHERE THE RUBBER HOSE CONNECTS TO STEEL LINE.
• INSERT RUBBER RETURN LINE HOSE SECTION IN AN APPROVED GASOLINE CONTAINER.
• ENERGIZE THE FUEL SYSTEM BY TURNING THE IGNITION KEY "ON" AS DESCRIBED IN CHART A-7 1 OF 2.
• NOTE FUEL PRESSURE GAUGE.
PRESSURE IS BETWEEN 190 kPa (27.6 psi, 1.9 bar) AND 210 kPa (30.5 psi, 2.1 bar).
PRESSURE IS ABOVE 210 kPa (30.5 psi, 2.1 bar).
LOCATE AND CORRECT RESTRICTED FUEL RETURN LINE TO FUEL TANK.
CHECK FOR RESTRICTED FUEL RETURN LINE FROM THROTTLE BODY INJECTION UNIT TO WHERE LINE WAS DISCONNECTED. IF LINE IS OK, REPLACE PRESSURE REGULATOR.
4-27-93
NS 14406



CODE 13
NO OXYGEN SENSOR SIGNAL
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The electronic control module applies a reference voltage of approximately 450 millivolts between terminals "D7" and "D6". The oxygen sensor varies the voltage within a range of about 1 volt if the exhaust is rich, and down through about 10 millivolt if exhaust is lean. Code 13 is set when the voltage does not vary on Circuit 32 within a predetermined amount of time.

The sensor is like an open circuit and produces no voltage when it is below 315°C. An open sensor circuit, or a cold sensor causes "Open Loop" operation.

The heater circuit of the oxygen sensor is turned "ON" by the ignition relay when the engine is running.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 13 will set:
   - Engine has been running longer than 40 seconds.
   - Engine coolant temperature greater than 77°C.
   - Throttle position sensor signal above 6% (about 0.3 volt above closed throttle voltage).
   - Oxygen sensor signal voltage steady between 350 and 550 millivolts for 3 seconds.

   If the conditions for a Code 13 exist, the system will not go into "Closed Loop."
2. This test checks the oxygen sensor's heating element. The heating element resistance should be 3.5 ohms at 20°C or 13.2 ohms at 595°C. At room temperature (20°C) the heater resistance should be 3.5–4.5Ω, normally it should be about 3.8Ω.
3. This will determine if the sensor is at fault.
4. For this test use only a high impedance digital voltmeter. This test checks the continuity of Circuit 32 Pink wire and Circuit 33 Brown/White wire. If Circuit 33 Brown/White wire is open, the electronic control module voltage on Circuit 32 Pink wire will be over 600 mV.
5. If the air conditioning fuse was open, check the air conditioning fuse circuits or generator circuits for shorts.

Diagnostic Aids:

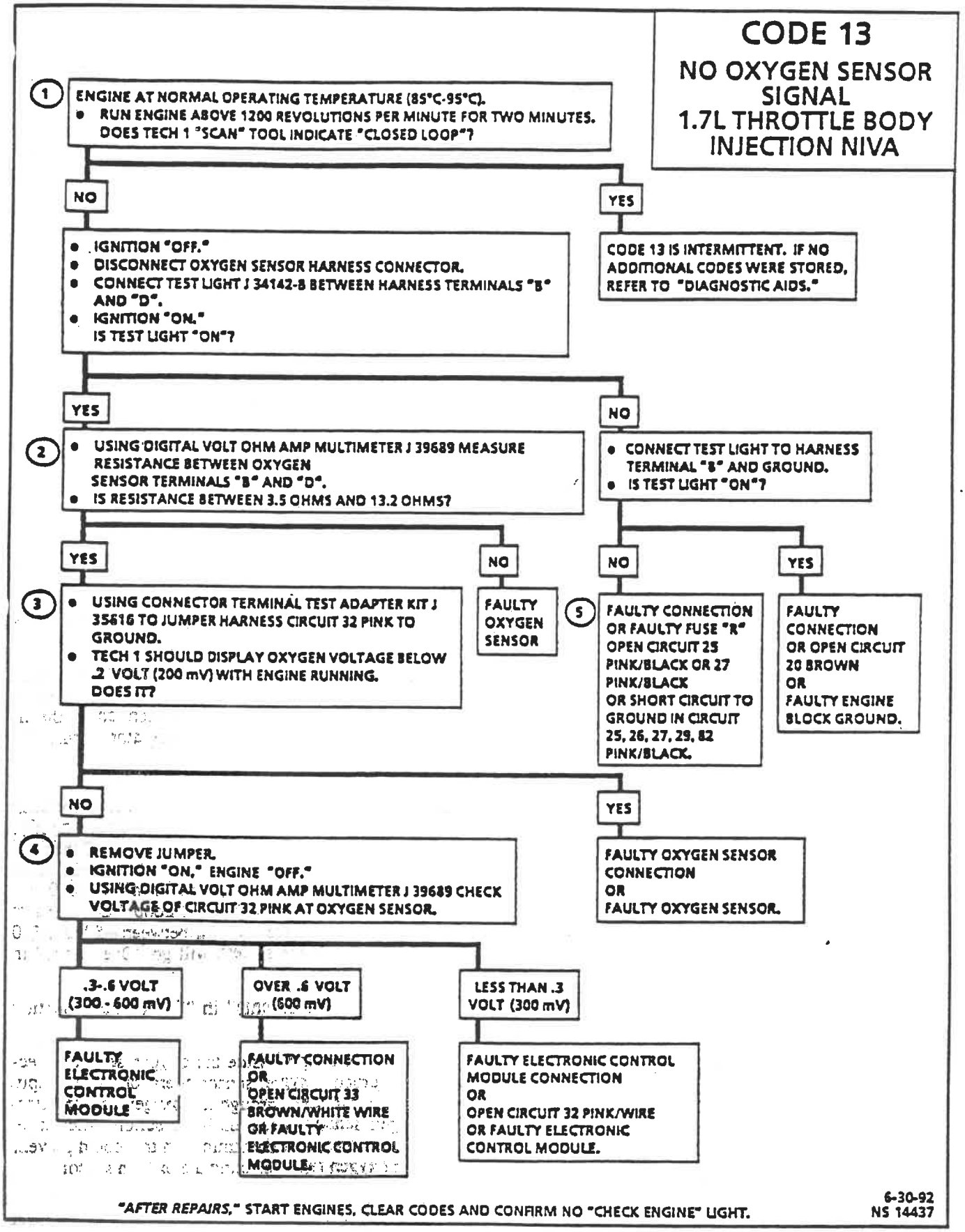
If the oxygen sensor heaters are not operating properly, system may go into "Open Loop" after extended idle.

Normal voltage varies between 10 mV to 1000 mV (.01 and 1.0 volt), while in "Closed Loop." Code 13 sets in one minute if voltage remains between 350 and 550 millivolt, however, the system will go "Open Loop" in about 15 seconds.

Refer to "Intermittents" in "Symptoms," Section "2.9B".

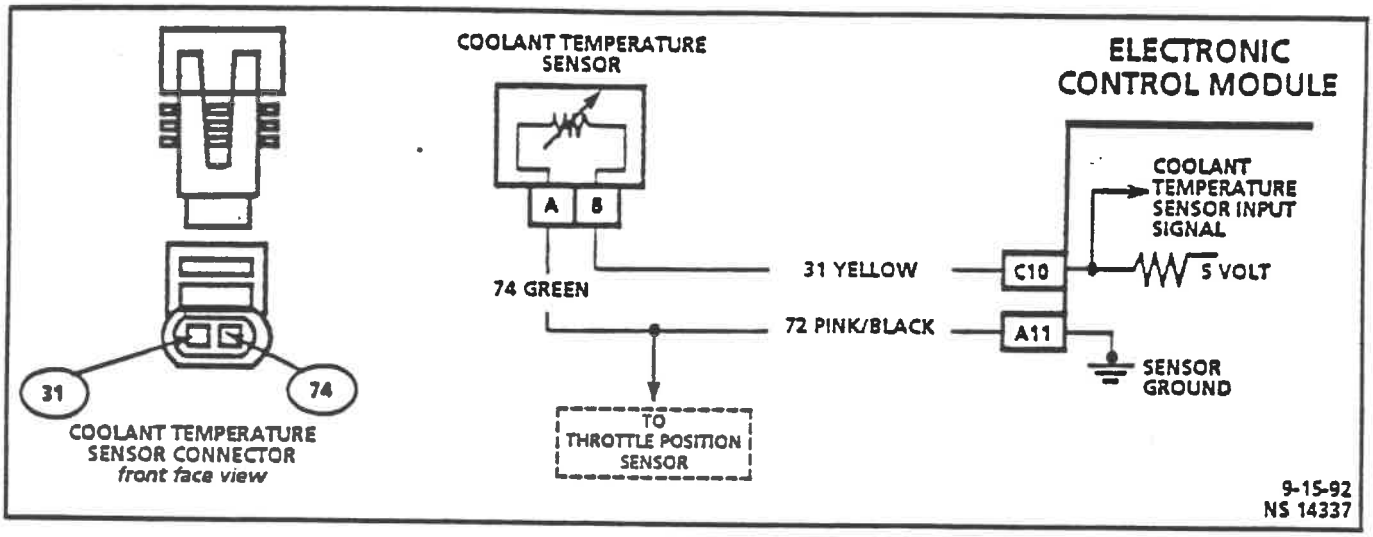
An oxygen supply inside the oxygen sensor is necessary for proper oxygen sensor operation. This supply of oxygen is supplied through the oxygen sensor wires. All oxygen sensor wires and connections should be inspected for breaks or contamination that could prevent reference oxygen from reaching the oxygen sensor.

CODE 13
NO OXYGEN SENSOR SIGNAL 1.7L THROTTLE BODY INJECTION NIVA


1
ENGINE AT NORMAL OPERATING TEMPERATURE (85°C-95°C).
• RUN ENGINE ABOVE 1200 REVOLUTIONS PER MINUTE FOR TWO MINUTES.
DOES TECH 1 "SCAN" TOOL INDICATE "CLOSED LOOP"?
NO
YES
CODE 13 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS."
• IGNITION "OFF."
• DISCONNECT OXYGEN SENSOR HARNESS CONNECTOR.
• CONNECT TEST LIGHT J 34142-B BETWEEN HARNESS TERMINALS "B" AND "D".
• IGNITION "ON."
IS TEST LIGHT "ON"?
YES
NO
2
• USING DIGITAL VOLT OHM AMP MULTIMETER J 39689 MEASURE RESISTANCE BETWEEN OXYGEN SENSOR TERMINALS "B" AND "D".
• IS RESISTANCE BETWEEN 3.5 OHMS AND 13.2 OHMS?
• CONNECT TEST LIGHT TO HARNESS TERMINAL "B" AND GROUND.
• IS TEST LIGHT "ON"?
YES
NO
NO
YES
3
• USING CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 TO JUMPER HARNESS CIRCUIT 32 PINK TO GROUND.
• TECH 1 SHOULD DISPLAY OXYGEN VOLTAGE BELOW .2 VOLT (200 mV) WITH ENGINE RUNNING.
DOES IT?
FAULTY OXYGEN SENSOR
5
FAULTY CONNECTION OR FAULTY FUSE "R" OPEN CIRCUIT 25 PINK/BLACK OR 27 PINK/BLACK OR SHORT CIRCUIT TO GROUND IN CIRCUIT 25, 26, 27, 29, 82 PINK/BLACK.
FAULTY CONNECTION OR OPEN CIRCUIT 20 BROWN OR FAULTY ENGINE BLOCK GROUND.
NO
YES
4
• REMOVE JUMPER.
• IGNITION "ON," ENGINE "OFF."
• USING DIGITAL VOLT OHM AMP MULTIMETER J 39689 CHECK VOLTAGE OF CIRCUIT 32 PINK AT OXYGEN SENSOR.
FAULTY OXYGEN SENSOR CONNECTION OR FAULTY OXYGEN SENSOR.
.3-.6 VOLT (300 - 600 mV)
OVER .6 VOLT (600 mV)
LESS THAN .3 VOLT (300 mV)
FAULTY ELECTRONIC CONTROL MODULE
FAULTY CONNECTION OR OPEN CIRCUIT 33 BROWN/WHITE WIRE OR FAULTY ELECTRONIC CONTROL MODULE.
FAULTY ELECTRONIC CONTROL MODULE CONNECTION OR OPEN CIRCUIT 32 PINK/WIRE OR FAULTY ELECTRONIC CONTROL MODULE.

"AFTER REPAIRS," START ENGINES, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

6-30-92
NS 14437



CODE 14

COOLANT TEMPERATURE (SIGNAL VOLTAGE TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The coolant temperature sensor is a thermistor that controls the signal voltage to the electronic control module. The electronic control module applies about 5 volts on the Yellow wire from electronic control module terminal "C10" to the coolant temperature sensor, and "looks" at the voltage drop. When the engine coolant is cold the sensor (thermistor) resistance is high, therefore the electronic control module will "see" high signal voltage.

As the engine warms, the coolant sensor (thermistor) resistance becomes less, and the electronic control module sees a lower signal voltage. At normal engine operating temperature (85°C–95°C) the voltage will measure about 1.5 to 2.0 volts.

Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 14 will set if:
   - Engine has been running longer than 2 seconds.

   AND
   - Coolant temperature sensor input signal voltage indicates engine coolant temperature is above 135°C.
2. This test determines if the Circuit 31 Yellow wire from the coolant temperature sensor to electronic control module terminal "C10" is shorted to ground (low volts/resistance) which will set a Code 14.

Diagnostic Aids:

The Tech 1 "Scan" tool displays engine temperature in degrees Celsius. After the engine is started, the temperature should rise steadily to about 85–95°C then stabilize when the thermostat opens. Check terminals at the sensor for a good connection.

Refer to "Intermittents" in "Symptoms," Section "2.9B".

CODE 14

COOLANT TEMPERATURE (SIGNAL VOLTAGE TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA

1. • IGNITION "ON," ENGINE NOT RUNNING.
   • CONNECT TECH 1.
   • SELECT "F0: DATA LIST."
   DOES TECH 1 DISPLAY COOLANT TEMPERATURE OF 130°C OR HIGHER?

   - YES
     2. • DISCONNECT COOLANT TEMPERATURE SENSOR.
        • TECH 1 SHOULD DISPLAY COOLANT TEMPERATURE BELOW -30°C.
        DOES IT?
        - YES
          REPLACE COOLANT TEMPERATURE SENSOR.
        - NO
          CIRCUIT 31 YELLOW WIRE FROM THE COOLANT TEMPERATURE SENSOR TO ELECTRONIC CONTROL MODULE TERMINAL "C10" IS SHORTED TO GROUND
          OR
          CIRCUIT 31 YELLOW WIRE FROM THE COOLANT TEMPERATURE SENSOR TO ELECTRONIC CONTROL MODULE TERMINAL "C10" IS SHORTED TO COOLANT TEMPERATURE SENSOR AND THROTTLE POSITION SENSOR GROUND CIRCUIT, CIRCUIT 72 PINK/BLACK OR CIRCUIT 74 GREEN WIRE FROM THE COOLANT TEMPERATURE SENSOR AND THROTTLE POSITION SENSOR TO ELECTRONIC CONTROL MODULE TERMINAL "A11"
          OR FAULTY ELECTRONIC CONTROL MODULE.
   - NO
     CODE 14 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

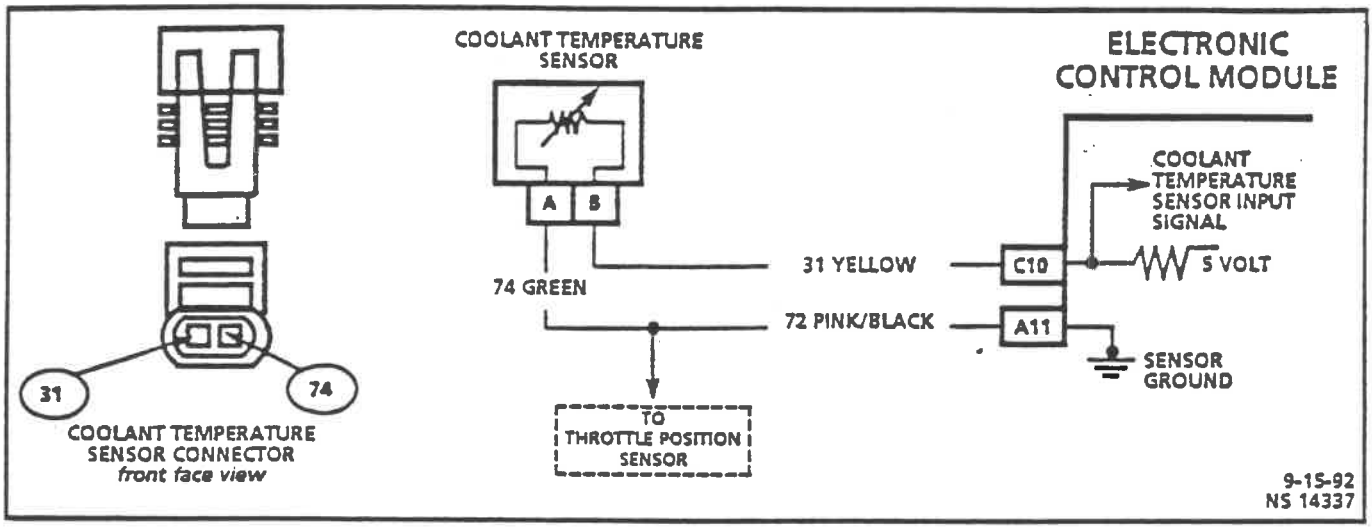
DIAGNOSTIC AID

COOLANT TEMPERATURE SENSOR
TEMPERATUR E VS. RESISTANCE VALUES (APPROXIMATE)

°C		OHMS
100		177
90		241
80		332
70		467
60		667
50		973
45		1188
40		1459
35		1802
30		2238
25		2796
20		3520
15		4450
10		5670
5		7280
0		9420
-5		12300
-10		16180
-15		21450
-20		28680
-30		52700
-40		100700

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

5-27-92
NS 14338



CODE 15

COOLANT TEMPERATURE (SIGNAL VOLTAGE TOO HIGH) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The coolant temperature sensor is a thermistor that controls the signal voltage to the electronic control module. The electronic control module applies about 5 volts on Circuit 31 Yellow wire from the electronic control module terminal "C10" to the coolant temperature sensor, and "looks" at the voltage drop. When the engine coolant is cold the sensor (thermistor) resistance is high, therefore the electronic control module will "see" high signal voltage.

As the engine warms, the coolant sensor (thermistor) resistance becomes less, and the electronic control module sees a lower signal voltage. At normal engine operating temperature (85°C–95°C) the voltage will measure about 1.5 to 2.0 volts.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 15 will set if:
   - Engine has been running longer than 58 seconds.

   AND
   - Coolant temperature sensor signal voltage indicates engine coolant temperature less than -37°C.
2. This test simulates a Code 14 - coolant temperature sensor (high temperature - low voltage/resistance indicated). If the electronic control module receives the low voltage/resistance signal (high temperature), and the Tech 1 "Scan" tool displays 130°C or above, the electronic control module and the coolant temperature sensor circuits are OK.
3. This tests for an open in the Circuit 31 Yellow wire from the coolant temperature sensor to electronic control module terminal "C10". When the Circuit 31 Yellow wire is jumpered/shorted to a good ground—the electronic control module should "see" a low resistance/voltage—high temperature on the coolant temperature sensor circuit (electronic control module terminal "C10"). If the Tech 1 displays a high temperature when the Yellow wire is shorted to ground, then the Circuit 31 Yellow wire to electronic control module terminal "C10" and the electronic control module are OK.

   Voltage between the Circuit 31 Yellow wire (coolant temperature sensor to electronic control module terminal "C10") and ground is normally 5 volts (the coolant temperature sensor connector disconnected and not jumpered/shorted to ground).

Diagnostic Aids:

The Tech 1 "Scan" tool reads engine coolant temperature in degrees Celsius. After the engine is started, the temperature should rise steadily to about 85-95°C, then stabilize when the thermostat opens.

If Code 21 - throttle position sensor is also set, check coolant temperature sensor and throttle position sensor ground circuit (Circuit 74 Green wire Circuit 72 Pink/Black wire) for faulty wiring or connections. Check terminals at sensor for a good connection.

Refer to "Intermittents" in "Symptoms," Section "2.9B".

CODE 15

COOLANT TEMPERATURE (SIGNAL VOLTAGE TOO HIGH) 1.7L THROTTLE BODY INJECTION NIVA

1
- IGNITION "ON," ENGINE RUNNING.
- CONNECT TECH 1.
- SELECT "F0: DATA LIST."

DOES TECH 1 DISPLAY COOLANT TEMPERATURE OF -30°C OR LESS?

YES

2
- DISCONNECT COOLANT TEMPERATURE SENSOR.
- USE CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 TO JUMPER HARNESS TERMINALS TOGETHER.
- TECH 1 SHOULD DISPLAY 130°C OR HIGHER.

DOES IT?

NO

3
- REMOVE JUMPER WIRE.
- USE CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 TO JUMPER THE CIRCUIT 31 YELLOW WIRE WHICH RUNS FROM THE COOLANT TEMPERATURE SENSOR TO ELECTRONIC CONTROL MODULE TERMINAL "C10" TO A GOOD GROUND.
- TECH 1 SHOULD DISPLAY OVER 130°C.

DOES IT?

YES

OPEN COOLANT TEMPERATURE SENSOR GROUND CIRCUIT (CIRCUIT 72 PINK/BLACK OR CIRCUIT 74 GREEN WIRE FROM THE COOLANT TEMPERATURE SENSOR AND THROTTLE POSITION SENSOR TO ENGINE CONTROL MODULE TERMINAL "A11"). FAULTY CONNECTIONS OR FAULTY ELECTRONIC CONTROL MODULE.

NO

OPEN IN YELLOW WIRE FROM THE COOLANT TEMPERATURE SENSOR TO ELECTRONIC CONTROL MODULE TERMINAL "C10". FAULTY CONNECTION OR FAULTY ELECTRONIC CONTROL MODULE.

NO

CODE 15 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES

FAULTY CONNECTION OR FAULTY COOLANT TEMPERATURE SENSOR.

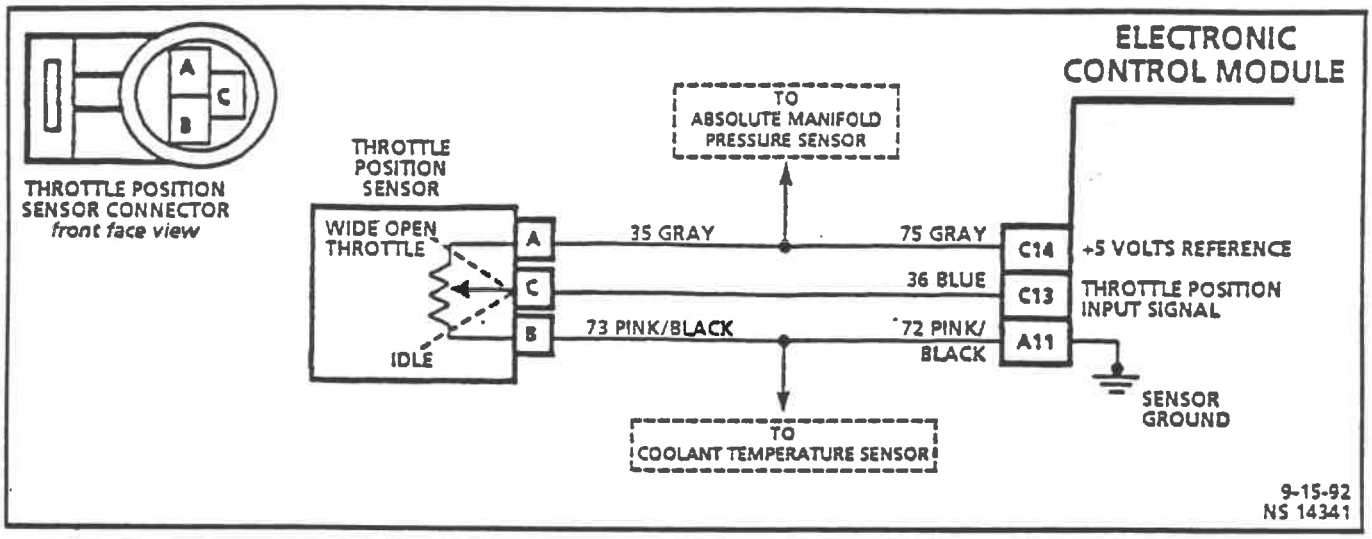
DIAGNOSTIC AID

COOLANT TEMPERATURE SENSOR
TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)

°C		OHMS
100		177
90		241
80		332
70		467
60		667
50		973
45		1188
40		1459
35		1802
30		2238
25		2796
20		3520
15		4450
10		5670
5		7280
0		9420
-5		12300
-10		16180
-15		21450
-20		28680
-30		52700
-40		100700

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

6-30-92
NS 14340



CODE 21

THROTTLE POSITION (SIGNAL VOLTAGE TOO HIGH) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The throttle position sensor provides a voltage signal that changes relative to the throttle blade. Throttle position sensor signal voltage varies from about 0.25 to 1.25 volts at idle to about 5 volts at wide open throttle.

The throttle position sensor signal is one of the inputs used by the electronic control module for fuel control and for most of the controlled outputs.

Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 21 will set if:
   - Throttle position sensor signal voltage is greater than 2.56 volts.
   - Manifold absolute pressure is less than 47 kPa.
   - Engine speed is less than or equal to 2000 revolutions per minute.
   - All conditions met for 2 seconds.
2. With the throttle position sensor disconnected, the throttle position sensor signal voltage should go low if the electronic control module and wiring are OK.
3. Probing coolant temperature sensor and throttle position sensor ground circuit (Circuit 72/73 Pink/Black wire from throttle position sensor connector terminal "B" to electronic control module terminal "A11") with a test light to 12 volts checks the sensor ground circuit. A faulty sensor ground can cause a Code 21.

Diagnostic Aids:

A Tech 1 "Scan" tool reads throttle position in volts. With ignition "ON" or at idle, throttle position sensor signal voltage should read between 0.25 to 1.25 volts with the throttle closed and increase at a steady rate as throttle is moved toward wide open throttle. An open in coolant temperature sensor and throttle position sensor ground circuit (Circuit 72/73 Pink/Black wire from throttle position sensor connector terminal "B" to electronic control module terminal "A11") will result in a Code 21.

Refer to "Intermittents" in "Symptoms," Section "2.9B".

CODE 21

THROTTLE POSITION (SIGNAL VOLTAGE TOO HIGH) 1.7L THROTTLE BODY INJECTION NIVA

1

- IGNITION "ON," ENGINE NOT RUNNING.
- CONNECT TECH 1 "SCAN" TOOL.
- SELECT "F0: DATA LIST."
- THROTTLE CLOSED.

DOES TECH 1 DISPLAY THROTTLE POSITION OVER 2.5 VOLTS?

YES

2

- DISCONNECT THROTTLE POSITION SENSOR. TECH 1 SHOULD DISPLAY THROTTLE POSITION BELOW .2 VOLT (200 mV). DOES IT?

YES

3

- WITH A TEST LIGHT J 34142-B CONNECTED TO + BATTERY VOLTAGE PROBE SENSOR GROUND CIRCUIT (73 PINK/BLACK) THROTTLE POSITION SENSOR CONNECTOR TERMINAL "B". IS LIGHT "ON"?

LIGHT "ON"

FAULTY CONNECTION OR FAULTY THROTTLE POSITION SENSOR.

LIGHT "OFF"

OPEN SENSOR GROUND CIRCUIT (CIRCUIT 72 OR 73PINK/BLACK WIRE FROM THROTTLE POSITION SENSOR CONNECTOR TERMINAL "B" TO ELECTRONIC CONTROL MODULE TERMINAL "A11")
OR FAULTY ELECTRONIC CONTROL MODULE.

NO

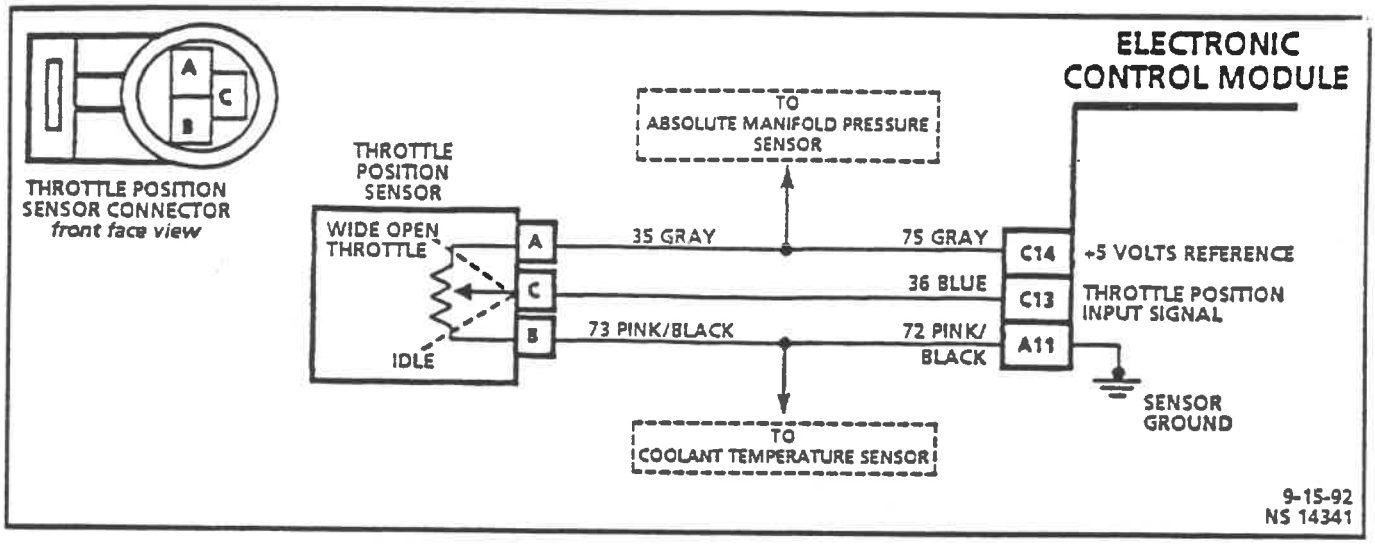
CODE 21 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

THROTTLE POSITION SENSOR SIGNAL CIRCUIT 36, BLUE WIRE FROM THROTTLE POSITION SENSOR CONNECTOR TERMINAL "C" TO ELECTRONIC CONTROL MODULE TERMINAL "C13", IS SHORTED TO VOLTAGE
OR FAULTY ELECTRONIC CONTROL MODULE.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

5-27-92
NS 14342



CODE 22

THROTTLE POSITION (SIGNAL VOLTAGE TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The throttle position sensor provides a voltage signal that changes relative to the throttle blade. Throttle position sensor signal voltage varies from about 0.25 to 1.25 volts at idle to about 5 volts at wide open throttle.

The throttle position sensor signal is one of the inputs used by the electronic control module for fuel control and for most of the electronic control module controlled outputs.

Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 22 will set if:
   - Engine has been running.
   - Throttle position sensor signal voltage is less than 0.16 volt.

   The throttle position sensor has an auto zeroing feature. If the voltage reading is within the range of about 0.25 to 1.25 volts, the electronic control module will use that value as closed throttle. If the voltage reading is out of the auto zero range at closed throttle, check for a binding throttle cable or damaged linkage, if OK, continue with diagnosis.
2. This step simulates Code 21: (high voltage). If the electronic control module recognizes the high signal voltage, then the electronic control module and wiring are OK.
3. This simulates a high signal voltage to check for an open in throttle position sensor signal input circuit (Circuit 36 Blue wire from throttle position sensor terminal "C" to electronic control module terminal "C13"). The Tech 1 "Scan" tool will not read up to 12 volts, but what is important is that the electronic control module recognizes the signal on throttle position sensor signal input circuit.

Diagnostic Aids:

A Tech 1 "Scan" tool reads throttle position in volts. With ignition "ON" or at idle, throttle position sensor signal voltage should read between 0.25 to 1.25 volts with the throttle closed and increase at a steady rate as throttle is moved toward wide open throttle.

An open or short to ground in +5 volt reference circuit (Circuit 35/75 Gray wire from throttle position sensor terminal "A" to electronic control module terminal "C14") or throttle position sensor signal input circuit (Circuit 36 Blue wire from throttle position sensor terminal "C" to electronic control module terminal "C13") will result in a Code 22.

Refer to "Intermittents" in "Symptoms," Section "2.9B".

CODE 22

THROTTLE POSITION (SIGNAL VOLTAGE TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA

1

- IGNITION "ON," ENGINE NOT RUNNING.
- CONNECT TECH 1 "SCAN" TOOL.
- SELECT "F0: DATA LIST."
- THROTTLE CLOSED.

DOES TECH 1 DISPLAY THROTTLE POSITION 0.2V (200 mV) OR BELOW?

NO → CODE 22 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES

2

- DISCONNECT THROTTLE POSITION SENSOR CONNECTOR.
- USING CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 TO JUMPER THROTTLE POSITION SENSOR CONNECTOR TERMINALS "A" AND "C" (CIRCUIT 35/75 GRAY WIRE FROM THROTTLE POSITION SENSOR TERMINAL "A" TO ELECTRONIC CONTROL MODULE TERMINAL "C14" AND CIRCUIT 36BLUE WIRE FROM THROTTLE POSITION SENSOR TERMINAL "C" TO ELECTRONIC CONTROL MODULE TERMINAL "C13").

TECH 1 "SCAN" TOOL SHOULD DISPLAY THROTTLE POSITION OVER 4.0V (4000 mV).
DOES IT?

YES → FAULTY THROTTLE POSITION SENSOR CONNECTION
OR
FAULTY THROTTLE POSITION SENSOR.

NO

3

- WITH A TEST LIGHT J 34142-B CONNECTED TO + BATTERY VOLTAGE USE CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 TO PROBE THROTTLE POSITION SENSOR TERMINAL "C" (THROTTLE POSITION SENSOR INPUT SIGNAL CIRCUIT 36 BLUE). TECH 1 SHOULD DISPLAY THROTTLE POSITION OVER 4.0V (4000 mV).

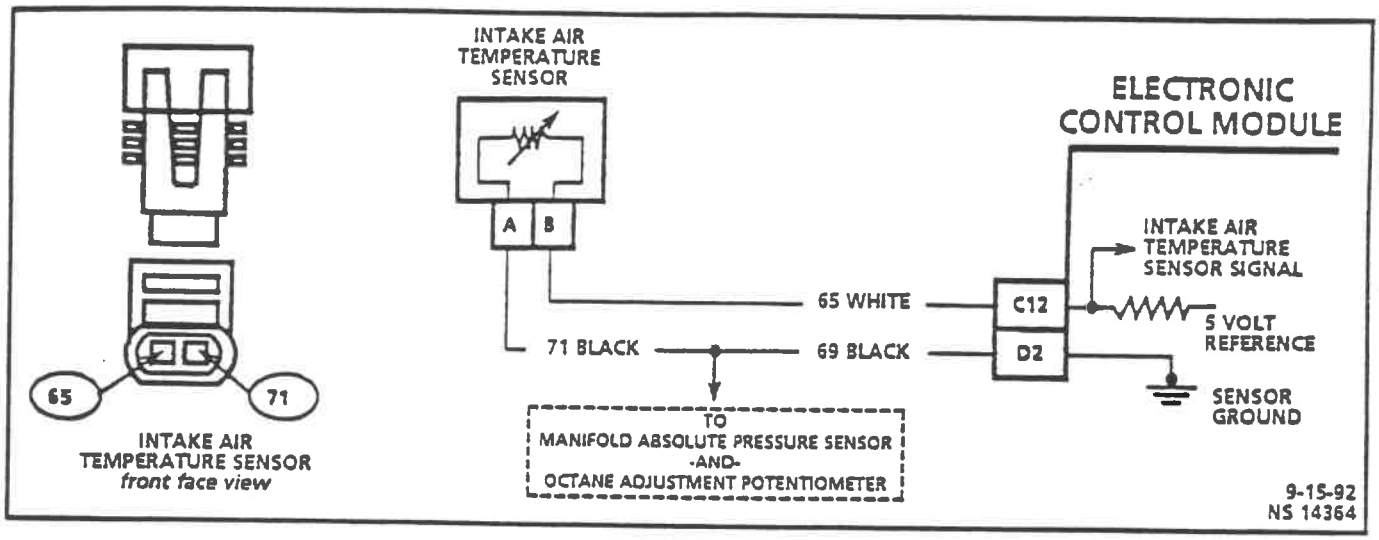
DOES IT?

NO → THROTTLE POSITION SENSOR INPUT SIGNAL CIRCUIT (CIRCUIT 36 BLUE WIRE FROM ELECTRONIC CONTROL MODULE TERMINAL "C13" TO THROTTLE POSITION SENSOR TERMINAL "C") IS OPEN OR SHORTED TO GROUND, OR SHORTED TO THROTTLE POSITION SENSOR GROUND CIRCUIT (CIRCUIT 72/73 PINK/BLACK WIRE)
OR
FAULTY ELECTRONIC CONTROL MODULE CONNECTION
OR FAULTY ELECTRONIC CONTROL MODULE.

YES → 5 VOLT REFERENCE CIRCUIT (CIRCUIT 35/75 GRAY WIRE FROM ELECTRONIC CONTROL MODULE TERMINAL "C14" TO THROTTLE POSITION SENSOR TERMINAL "A") IS OPEN OR SHORTED TO GROUND
OR
FAULTY CONNECTION
OR FAULTY ELECTRONIC CONTROL MODULE.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

6-2-92
NS 14361



CODE 23

INTAKE AIR TEMPERATURE (SIGNAL VOLTAGE TOO HIGH) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The intake air temperature sensor uses a thermistor to control the signal voltage to the electronic control module. The electronic control module applies a voltage (about 5 volts) on Circuit 65 White wire to the sensor. When the intake air is cold the sensor (thermistor) resistance is high, therefore, the electronic control module will see a high signal voltage. As the air warms, the sensor resistance becomes low, therefore, the electronic control module will see a low voltage.

The intake air temperature sensor is located in the air cleaner.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 23 will set if:
   - Ignition "ON."

   OR
   - Engine has been running longer than 29 seconds.
   - Intake air temperature sensor signal voltage indicates an intake air temperature below 39°C.
2. A Code 23 will set due to an open sensor wire or connection. This test will determine if the wiring and electronic control module are OK.
3. This will determine if the signal Circuit 65 White wire or the intake air temperature sensor ground Circuit 69/71 Black wire is open.

Diagnostic Aids:

A Tech 1 "Scan" tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rises as engine compartment temperature increases.

A faulty connection or an open in Circuit 65 White wire or Circuit 69/71 Black wire will result in a Code 23 and or Code 33, Code 54.

Refer to Intermittents in "Symptoms," Section "2.9B".

CODE 23

INTAKE AIR TEMPERATURE (SIGNAL VOLTAGE TOO HIGH) 1.7L THROTTLE BODY INJECTION NIVA

1. • DOES TECH 1 SCAN TOOL DISPLAY INTAKE AIR TEMPERATURE -30°C OR COLDER?

YES

2. • DISCONNECT INTAKE AIR TEMPERATURE SENSOR.
   • JUMPER HARNESS TERMINALS "A" AND "B" TOGETHER.
   • TECH 1 SCAN TOOL SHOULD DISPLAY TEMPERATURE OVER 130°C.
   DOES IT?

YES

FAULTY CONNECTION OR FAULTY SENSOR.

NO

3. • USING CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 TO JUMPER CIRCUIT 65 WHITE WIRE TO GROUND.
   • TECH 1 SCAN TOOL SHOULD DISPLAY TEMPERATURE OVER 130°C.
   DOES IT?

YES

OPEN SENSOR GROUND CIRCUIT 69/71 BLACK WIRE, OR FAULTY CONNECTION OR FAULTY ELECTRONIC CONTROL MODULE.

NO

OPEN CIRCUIT 65 WHITE WIRE, OR FAULTY CONNECTION OR FAULTY ELECTRONIC CONTROL MODULE.

NO

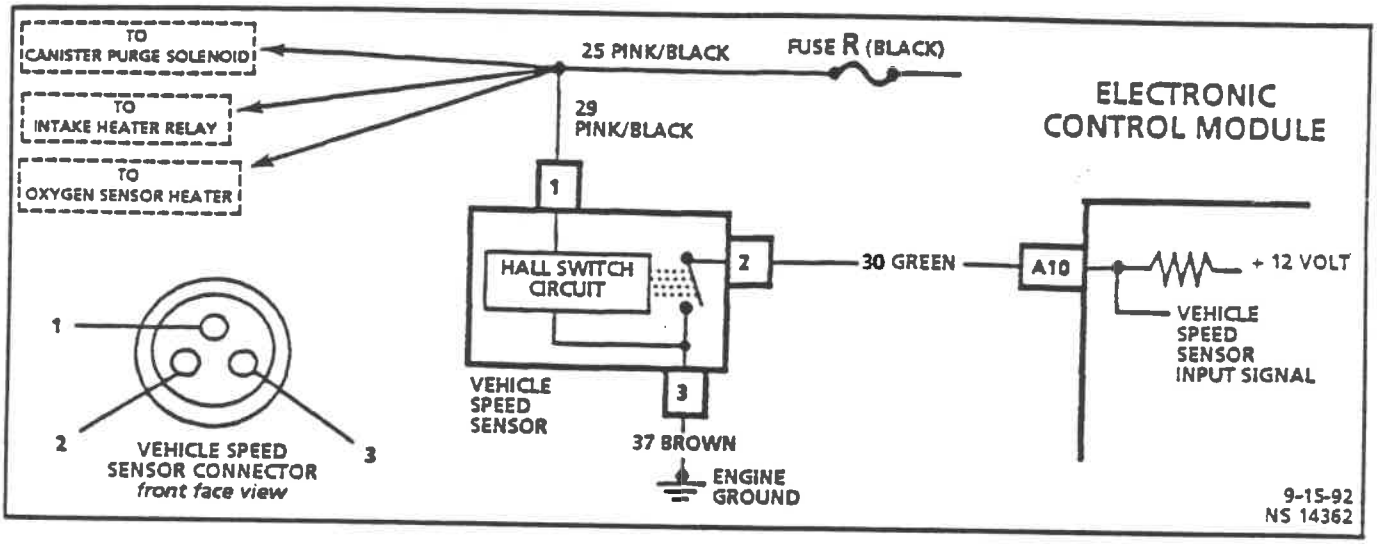
CODE 23 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

DIAGNOSTIC AID

INTAKE AIR TEMPERATURE SENSOR TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)	
°C	OHMS
100	177
90	241
80	332
70	467
60	667
50	973
45	1188
40	1459
35	1802
30	2238
25	2796
20	3520
15	4450
10	5670
5	7280
0	9420
-5	12300
-10	16180
-15	21450
-20	28680
-30	52700
-40	100700

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

5-26-92
NS 14343



CODE 24

NO VEHICLE SPEED SIGNAL
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The electronic control module terminal "A10" applies and monitors 12 volts on vehicle speed sensor input signal Circuit 30 Green wire. The vehicle speed sensor alternately grounds vehicle speed sensor input signal circuit when the drive wheels are turning. This pulsing action takes place about 1242 times per kilometer and the electronic control module calculates vehicle speed based on the time between "pulses."

Tech 1 "Scan" tool reading should closely match the speedometer reading with the drive wheels turning and vehicle speed over about 3 km/h.

Disregard a Code 24 set when drive wheels are not turning.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

Code 24 will set if the following conditions exist for longer than 3 seconds.

- Codes 21, 22, 33 and 34 are not set.
- Engine revolutions per minute are between 2000 and 4400.
- Manifold absolute pressure is less than 23 kPa.
- The throttle is closed.
- Vehicle speed signal indicates less than or equal to 10 km/h.

1. This test uses the "Scan" tool to verify the vehicle speed sensor sensor operation.
2. The electronic control module supplies 12 volts to vehicle speed sensor input signal circuit but this signal will not light the test light. This step verifies that vehicle speed sensor input signal circuit is not shorted to a voltage source.
3. By probing vehicle speed sensor input signal circuit with the test light several times a second a vehicle speed signal should be generated and displayed on the "Scan" tool.
4. This test must be done using a voltmeter and will check for the 12 volts being supplied to vehicle speed sensor input signal circuit by the electronic control module.
5. This is the ignition feed circuit that supplies operating power to the vehicle speed sensor.
6. This circuit supplies the ground path for vehicle speed sensor operation. If this circuit is open, vehicle speed sensor cannot pulse vehicle speed sensor input signal circuit to ground.

Diagnostic Aids:

The Tech 1 "Scan" tool should indicate a vehicle speed whenever the drive wheels are turning greater than 3 km/h.

If vehicle speed signal is not present, engine may stall at closed throttle coastdown speeds due to wrong vehicle speed data to electronic control module.

Refer to "Intermittents" in "Symptoms," Section "2.9B".

CODE 24

NO VEHICLE SPEED SIGNAL
1.7L THROTTLE BODY INJECTION NIVA

DISREGARD CODE 24, IF SET WHILE DRIVE WHEELS ARE NOT TURNING

1
- ATTACH TECH 1 "SCAN" TOOL.
- SELECT "FØ: DATA LIST."
- RAISE VEHICLE SO THAT ALL TIRES CAN ROTATE FREELY.
- WITH ENGINE IDLING IN GEAR, TECH 1 "SCAN" TOOL SHOULD DISPLAY KM/H ABOVE 0. DOES IT?

NO

2
- IGNITION "ON" ENGINE NOT RUNNING.
- DISCONNECT "VEHICLE SPEED SENSOR" CONNECTOR.
- WITH TEST LIGHT J 34142-B CONNECTED TO GROUND PROBE VEHICLE SPEED SENSOR INPUT SIGNAL CIRCUIT (CIRCUIT 30 GREEN WIRE TO ELECTRONIC CONTROL MODULE TERMINAL "A10"), IS LIGHT "ON"?

NO

3
- USING TEST LIGHT J 34142-B MOMENTARILY TOUCH VEHICLE SPEED SENSOR INPUT SIGNAL CIRCUIT (CIRCUIT 30 GREEN WIRE TO ELECTRONIC CONTROL MODULE TERMINAL "A10") SEVERAL TIMES A SECOND WHILE OBSERVING VEHICLE SPEED SENSOR SIGNAL ON TECH 1 "SCAN" TOOL. DOES TECH 1 DISPLAY VEHICLE SPEED ABOVE 0 KM/H?

NO

4
- USING DIGITAL VOLT OHM AMP MULTIMETER, CHECK VOLTAGE ON VEHICLE SPEED SENSOR INPUT SIGNAL CIRCUIT (CIRCUIT 30 GREEN WIRE TO ELECTRONIC CONTROL MODULE TERMINAL "A10"). IS VOLTAGE GREATER THAN 10 VOLTS?

YES

REPLACE ELECTRONIC CONTROL MODULE.

NO

VEHICLE SPEED SENSOR INPUT SIGNAL CIRCUIT (CIRCUIT 30 GREEN WIRE TO ELECTRONIC CONTROL MODULE TERMINAL "A10") OPEN, SHORTED TO GROUND OR FAULTY ELECTRONIC CONTROL MODULE.

YES

5
- WITH TEST LIGHT J 34142-B CONNECTED TO GROUND, PROBE POWER SOURCE TO VEHICLE SPEED SENSOR (CIRCUIT 29/25 PINK/BLACK WIRE FROM FUSE "R" TO VEHICLE SPEED SENSOR CONNECTOR TERMINAL "1"). IS LIGHT "ON"?

YES

6
- WITH TEST LIGHT J 34142-B CONNECTED TO 12 VOLTS PROBE VEHICLE SPEED SENSOR GROUND CIRCUIT (CIRCUIT 37 BROWN WIRE FROM VEHICLE SPEED SENSOR CONNECTOR TERMINAL "3" TO HARNESS GROUND). IS TEST LIGHT "ON"?

YES

FAULTY VEHICLE SPEED SENSOR CONNECTION OR FAULTY VEHICLE SPEED SENSOR.

NO

REPAIR OPEN VEHICLE SPEED SENSOR GROUND CIRCUIT (CIRCUIT 37 BROWN WIRE FROM VEHICLE SPEED SENSOR CONNECTOR TERMINAL "3" TO HARNESS GROUND).

NO

CHECK FUSE "R". REPAIR OPEN IN VEHICLE SPEED SENSOR POWER SOURCE CIRCUIT 29/25 PINK/BLACK.

YES

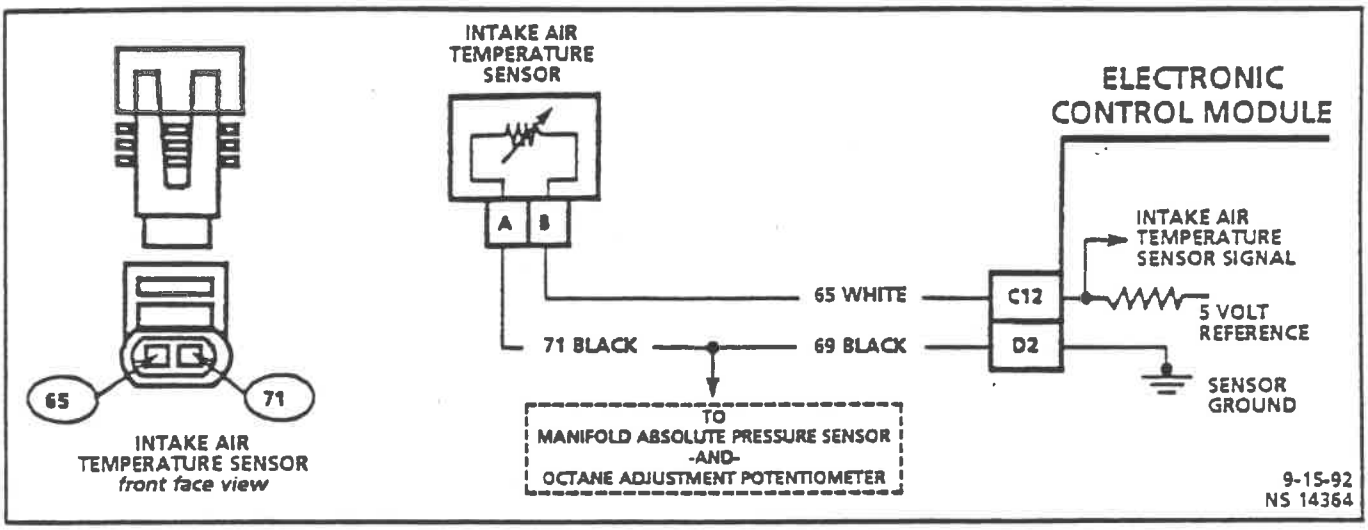
CODE 24 IS INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES

REPAIR SHORT TO VOLTAGE IN VEHICLE SPEED SENSOR INPUT SIGNAL CIRCUIT (CIRCUIT 30 GREEN WIRE TO ELECTRONIC CONTROL MODULE TERMINAL "A10").

5-26-92
NS 14363

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 25

INTAKE AIR TEMPERATURE (SIGNAL VOLTAGE TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The intake air temperature sensor uses a thermistor to control the signal voltage to the electronic control module. The electronic control module applies a voltage (about 5 volts) on Circuit 65 White to the sensor. When intake air is cold, the sensor (thermistor) resistance is high. Therefore, the electronic control module will see a high signal voltage. As the air warms, the sensor resistance becomes less and the voltage drops.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

A Code 25 will set if:

1. Intake air temperature greater than 140°C is detected for approximately 1 second with the engine running.

Diagnostic Aids:

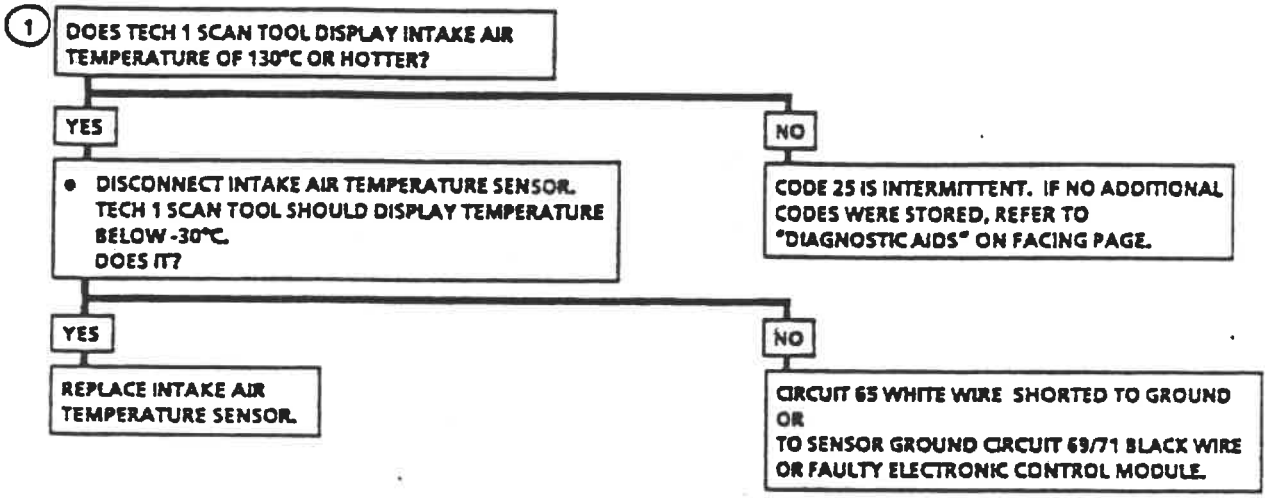
If the engine has been allowed to cool to an ambient temperature (overnight), the coolant temperature and intake air temperature may be checked with a Tech 1 "Scan" tool and should read close to each other.

A Code 25 will result if Circuit 65 White is shorted to ground.

If Code 25 is intermittent, refer to "Symptoms," Section "2.9B."

CODE 25

INTAKE AIR TEMPERATURE (SIGNAL VOLTAGE TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA

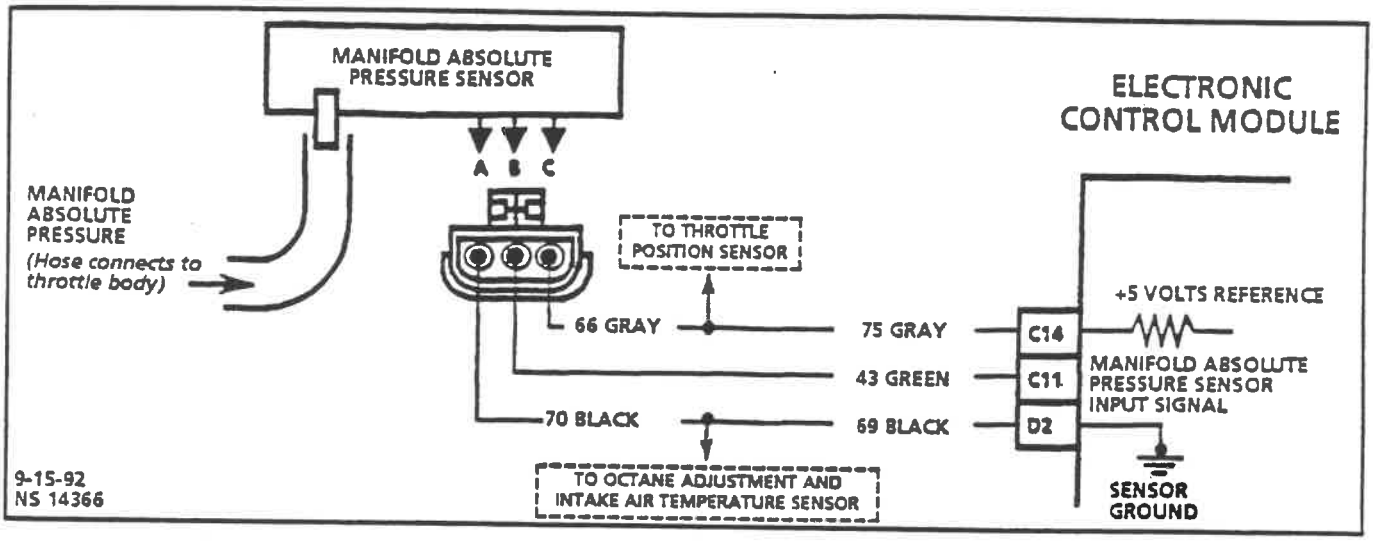

1
DOES TECH 1 SCAN TOOL DISPLAY INTAKE AIR TEMPERATURE OF 130°C OR HOTTER?
YES
NO
• DISCONNECT INTAKE AIR TEMPERATURE SENSOR. TECH 1 SCAN TOOL SHOULD DISPLAY TEMPERATURE BELOW -30°C. DOES IT?
CODE 25 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
YES
NO
REPLACE INTAKE AIR TEMPERATURE SENSOR.
CIRCUIT 65 WHITE WIRE SHORTED TO GROUND OR TO SENSOR GROUND CIRCUIT 69/71 BLACK WIRE OR FAULTY ELECTRONIC CONTROL MODULE.

DIAGNOSTIC AID

INTAKE AIR TEMPERATURE SENSOR TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C		OHMS
100		177
90		241
80		332
70		467
60		667
50		973
45		1188
40		1459
35		1802
30		2238
25		2796
20		3520
15		4450
10		5670
5		7280
0		9420
-5		12300
-10		16180
-15		21450
-20		28680
-30		52700
-40		100700

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

5-26-92
NS 14365



CODE 33
MANIFOLD ABSOLUTE PRESSURE (SIGNAL VOLTAGE TOO HIGH) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The manifold absolute pressure sensor responds to changes in intake manifold pressure. The electronic control module receives this information as a signal voltage that will vary from about 1–1.5 volts at idle to 4–4.5 volts at wide open throttle.

The Tech 1 "Scan" tool displays manifold pressure in volts and kilopascals pressure. Low pressure reads a low voltage while a high pressure reads a high voltage.

If the manifold absolute pressure sensor fails the electronic control module will substitute a fixed manifold absolute pressure value and use the throttle position sensor to control fuel delivery.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 33 will set if:
   - Engine has been running.
   - Malfunction Code 21 or 22 are not set.
   - Throttle position sensor less than 1.6%.
   - Manifold absolute pressure sensor signal voltage is too high (greater than 76 kPa of pressure) for a time greater than approximately five seconds.

   Engine misfire or a low unstable idle may set Code 33. Disconnect manifold absolute pressure sensor electrical connector and system will use a default manifold absolute pressure value. If the misfire or idle condition remains, see "Symptoms," in Section "2.9B".
2. If the electronic control module recognizes and the Tech 1 "Scan" tool displays the low manifold absolute pressure signal, the electronic control module and wiring are OK.

Diagnostic Aids:

If the idle is rough or unstable, refer to "Symptoms," Section "2.9B" for items which can cause an unstable idle.

An open in octane adjustment, intake air temperature sensor and manifold absolute pressure sensor ground circuit (Circuit 69/70 Black wire from manifold absolute pressure sensor connector terminal "A" to electronic control module terminal "D2") will result in a Code 33, and/or Code 23 and Code 54.

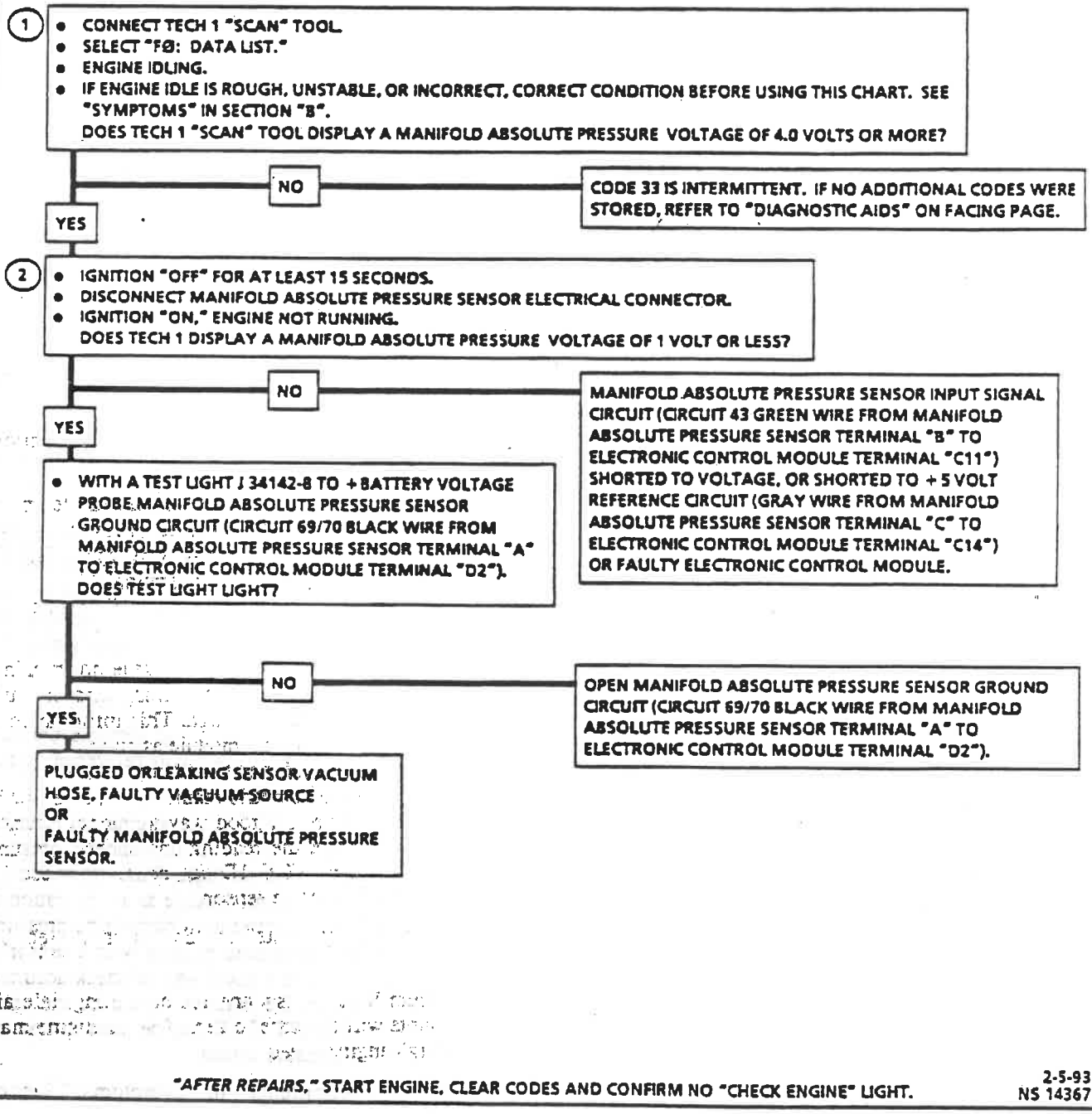
With the ignition "ON" and the engine not running, the manifold pressure is equal to atmospheric pressure and the signal voltage may be high. This information is used by the electronic control module as an indication of vehicle altitude and is referred to as barometric pressure. Comparison of this barometric reading with a sensor in a known good vehicle is a good way to check accuracy of a "suspect" sensor, the reading should be the same +0.2 volt. Also, CHART C-1D can be used to test the manifold absolute pressure sensor.

Refer to "Intermittents" in "Symptoms," Section "2.9B".

If vacuum hose is disconnected or leaking, idle air control counts will be close to zero (0) and engine may idle with high engine speed.

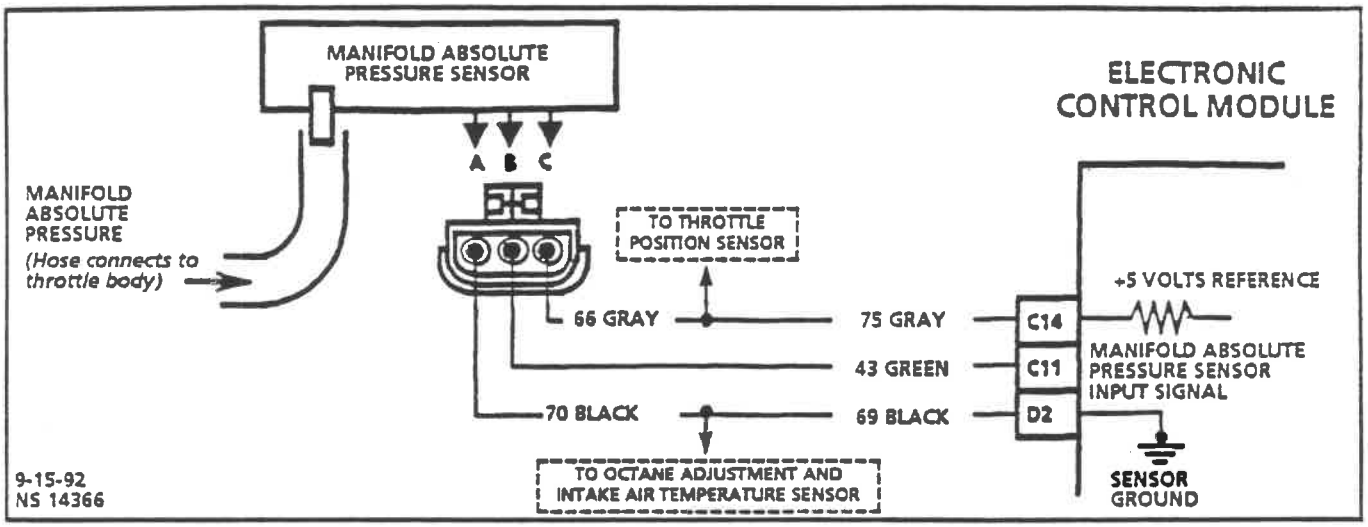
CODE 33

MANIFOLD ABSOLUTE PRESSURE (SIGNAL VOLTAGE TOO HIGH) 1.7L THROTTLE BODY INJECTION NIVA


1
• CONNECT TECH 1 "SCAN" TOOL.
• SELECT "F0: DATA LIST."
• ENGINE IDLING.
• IF ENGINE IDLE IS ROUGH, UNSTABLE, OR INCORRECT, CORRECT CONDITION BEFORE USING THIS CHART. SEE "SYMPTOMS" IN SECTION "B".
DOES TECH 1 "SCAN" TOOL DISPLAY A MANIFOLD ABSOLUTE PRESSURE VOLTAGE OF 4.0 VOLTS OR MORE?
NO
CODE 33 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
YES
2
• IGNITION "OFF" FOR AT LEAST 15 SECONDS.
• DISCONNECT MANIFOLD ABSOLUTE PRESSURE SENSOR ELECTRICAL CONNECTOR.
• IGNITION "ON," ENGINE NOT RUNNING.
DOES TECH 1 DISPLAY A MANIFOLD ABSOLUTE PRESSURE VOLTAGE OF 1 VOLT OR LESS?
NO
MANIFOLD ABSOLUTE PRESSURE SENSOR INPUT SIGNAL CIRCUIT (CIRCUIT 43 GREEN WIRE FROM MANIFOLD ABSOLUTE PRESSURE SENSOR TERMINAL "B" TO ELECTRONIC CONTROL MODULE TERMINAL "C11") SHORTED TO VOLTAGE, OR SHORTED TO + 5 VOLT REFERENCE CIRCUIT (GRAY WIRE FROM MANIFOLD ABSOLUTE PRESSURE SENSOR TERMINAL "C" TO ELECTRONIC CONTROL MODULE TERMINAL "C14") OR FAULTY ELECTRONIC CONTROL MODULE.
YES
• WITH A TEST LIGHT J 34142-8 TO + BATTERY VOLTAGE PROBE MANIFOLD ABSOLUTE PRESSURE SENSOR GROUND CIRCUIT (CIRCUIT 69/70 BLACK WIRE FROM MANIFOLD ABSOLUTE PRESSURE SENSOR TERMINAL "A" TO ELECTRONIC CONTROL MODULE TERMINAL "D2").
DOES TEST LIGHT LIGHT?
NO
OPEN MANIFOLD ABSOLUTE PRESSURE SENSOR GROUND CIRCUIT (CIRCUIT 69/70 BLACK WIRE FROM MANIFOLD ABSOLUTE PRESSURE SENSOR TERMINAL "A" TO ELECTRONIC CONTROL MODULE TERMINAL "D2").
YES
PLUGGED OR LEAKING SENSOR VACUUM HOSE, FAULTY VACUUM SOURCE OR FAULTY MANIFOLD ABSOLUTE PRESSURE SENSOR.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

2-5-93
NS 14367



CODE 34

MANIFOLD ABSOLUTE PRESSURE (SIGNAL VOLTAGE TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The manifold absolute pressure sensor responds to changes in intake manifold pressure. The electronic control module receives this information as a signal voltage that will vary from about 1–1.5 volts at idle to 4–4.5 volts at wide open throttle.

The Tech 1 "Scan" tool displays manifold pressure in voltage and kilopascals pressure. Low pressure reads a low voltage while a high pressure reads a high voltage.

If the manifold absolute pressure sensor fails the electronic control module will substitute a fixed manifold absolute pressure value and use the throttle position sensor to control fuel delivery.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 34 will set if:
   - Malfunction Code 21 is not set.
   - Engine speed is less than 1200 revolutions per minute.
   - Manifold absolute pressure sensor signal voltage is too low (less than 14 kPa of pressure) for less than one second.

   OR
   - Malfunction Code 21 is not set.
   - Engine speed is greater than 1200 revolutions per minute.
   - Throttle position greater than 20%.
   - Manifold absolute pressure sensor signal voltage is too low (less than 14 kPa of pressure) for less than one second.
2. If the electronic control module recognizes the high manifold absolute pressure signal, the electronic control module and wiring are OK.
3. The Tech 1 "Scan" tool may not display 12 volts. The important thing is that the electronic control module recognizes the voltage as more than 4 volts, indicating that the electronic control module and manifold absolute pressure sensor input signal circuit are OK.

Diagnostic Aids:

An intermittent open in manifold absolute pressure sensor input signal circuit or +5 volt reference circuit will result in a Code 34.

With the ignition "ON" and the engine not running, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the electronic control module as an indication of vehicle altitude and is referred to as barometric pressure. Comparison of this barometric reading with a sensor in a known good vehicle is a good way to check accuracy of a "suspect" sensor, the reading should be the same ± 0.2 volt. Also, CHART C-1D can be used to test the manifold absolute pressure sensor.

Refer to "Intermittents" in "Symptoms," Section "2.9B".

CODE 34

MANIFOLD ABSOLUTE PRESSURE (SIGNAL VOLTAGE TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA

1
- CONNECT TECH 1 "SCAN" TOOL.
- SELECT "F0: DATA LIST."
- ENGINE IDLING.

DOES TECH 1 "SCAN" TOOL DISPLAY A MANIFOLD ABSOLUTE PRESSURE VOLTAGE BELOW 0.25 VOLT?

NO → CODE 34 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES

2
- IGNITION "OFF."
- DISCONNECT MANIFOLD ABSOLUTE PRESSURE SENSOR ELECTRICAL CONNECTOR.
- USING CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 TO JUMPER CONNECTOR TERMINALS "B" TO "C".
- IGNITION "ON."

DOES MANIFOLD ABSOLUTE PRESSURE VOLTAGE READ OVER 4.7 VOLTS?

YES → FAULTY CONNECTION OR FAULTY MANIFOLD ABSOLUTE PRESSURE SENSOR.

NO

3
- IGNITION "OFF."
- REMOVE JUMPER WIRE.
- WITH A TEST LIGHT J 34142-B CONNECTED TO +BATTERY VOLTAGE PROBE TERMINAL "B" GREEN WIRE (MANIFOLD ABSOLUTE PRESSURE SENSOR INPUT SIGNAL CIRCUIT).
- IGNITION "ON," ENGINE NOT RUNNING.

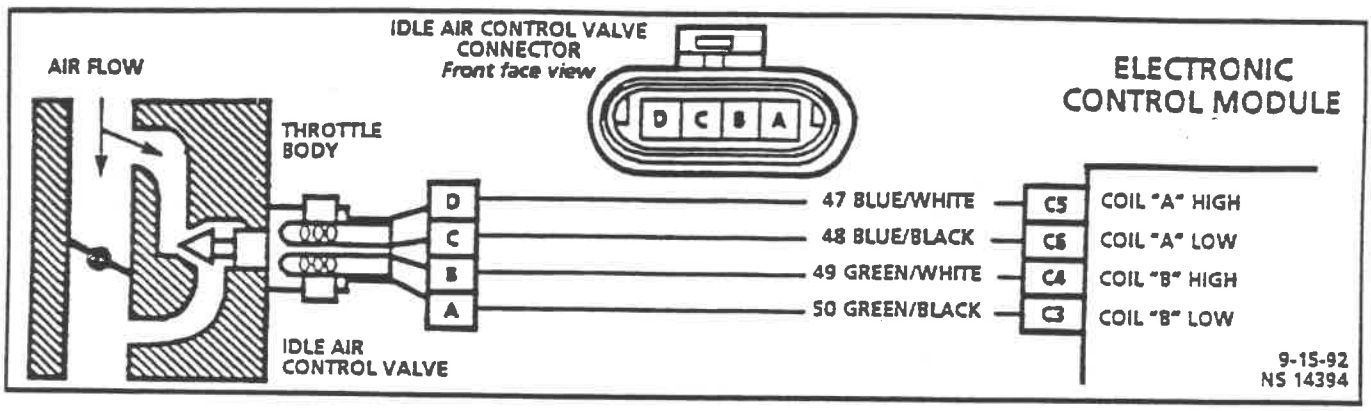
DOES TECH 1 "SCAN" TOOL READ OVER 4 VOLTS?

NO → MANIFOLD ABSOLUTE PRESSURE SENSOR INPUT SIGNAL CIRCUIT (CIRCUIT 43 GREEN WIRE FROM MANIFOLD ABSOLUTE PRESSURE TERMINAL "B" TO ELECTRONIC CONTROL MODULE TERMINAL "C11") OPEN
OR
SHORTED TO GROUND
OR
SHORTED TO SENSOR GROUND CIRCUIT 69/70 BLACK OR FAULTY ELECTRONIC CONTROL MODULE.

YES → +5 VOLT REFERENCE CIRCUIT (CIRCUIT 66/75 GRAY WIRE FROM MANIFOLD ABSOLUTE PRESSURE TERMINAL "C" TO ELECTRONIC CONTROL MODULE TERMINAL "C14") OPEN
OR
SHORTED TO GROUND
OR FAULTY ELECTRONIC CONTROL MODULE.

"AFTER REPAIRS." START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

5-26-92
NS 14369



CODE 35

IDLE SPEED ERROR
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

Code 35 will set if the closed throttle engine speed is 150 revolutions per minute above the desired (commanded) idle speed for more than 3 seconds. Review the general description of the idle air control operation in "Fuel Metering System," Section "1.2".

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. The Tech 1 "Scan" tool revolutions per minute control mode is used to extend and retract the Idle air control valve. The valve should move smoothly within the specified range. If the idle speed is commanded (idle air control extended) too low (below 700 revolutions per minute), the engine may stall. This may be normal and would not indicate a problem. Retracting the idle air control beyond its controlled range (above 1500 revolutions per minute) will cause a delay before the revolutions per minute start dropping. This too is normal.
2. This test uses the Tech 1 "Scan" tool to command the idle air control controlled idle speed. The electronic control module issues commands to obtain commanded idle speed. The node lights each should flash red and green to indicate a good circuit as the electronic control module issues commands. While the sequence of color is not important if either light is "OFF" or does not flash red and green, check the circuits for faults, beginning with poor terminal contacts.

Diagnostic Aids:

A slow, unstable, or fast idle may be caused by a non-idle air control system problem that cannot be overcome by the idle air control valve. Out of control range idle air control "Scan" tool counts will be above 60 if idle is too low and zero counts if idle is too high. The following checks should be made to repair a non-idle air control system problem:

- **Vacuum Leak (High Idle)** - If idle is too high, stop the engine. Fully extend (low) idle air control with tester. Start engine. If idle speed is above 800 revolutions per minute, locate and correct vacuum leak including crankcase ventilation system. Also check for binding of throttle blade or linkage.
- **System too lean (High Air/Fuel Ratio)** - The idle speed may be too high or too low. Engine speed may vary up and down and disconnecting the idle air control valve does not help. Code 44 may be set. Tech 1 "Scan" tool oxygen voltage will be less than 300 mV (0.3 volt). Check for low regulated fuel pressure, water in the fuel or a restricted injector.
- **System too rich (Low Air/Fuel Ratio)** - The idle speed will be too low. Tech 1 "Scan" tool idle air control counts will usually be above 80. System is obviously rich and may exhibit black smoke in exhaust.

  Tech 1 "Scan" tool oxygen voltage will be fixed above 800 mV (.8 volt).

  Check for high fuel pressure, leaking or sticking injector. Silicone contaminated oxygen sensors Tech 1 "Scan" tool voltage will be slow to respond.
- **Throttle Body** - Remove idle air control valve and inspect bore for foreign material.
- **Idle Air Control Valve Electrical Connections** - Idle air control valve connections should be carefully checked for proper contact.
- **Crankcase Ventilation System** - An incorrect or faulty positive crankcase ventilation system may result in an incorrect idle speed. Refer to CHART C-13.
- Refer to "Rough, Unstable, Incorrect Idle or Stalling" in "Symptoms," Section "2.9B".
- If intermittent poor driveability or idle symptoms are resolved by disconnecting the idle air control, carefully recheck connections, valve terminal resistance or replace idle air control.

CODE 35

IDLE SPEED ERROR
1.7L THROTTLE BODY INJECTION NIVA

(1)
- ENGINE AT NORMAL OPERATING TEMPERATURE (85° - 95°C).
- ENGINE IDLING IN NEUTRAL GEAR WITH PARKING BRAKE SET.
- AIR CONDITIONING "OFF."
- CONNECT TECH 1 "SCAN" TOOL.
- SELECT "MISC. TESTS," THEN "IDLE SYSTEM," THEN "IDLE CONTROL."
- WITH THE THROTTLE REMAINING CLOSED, COMMAND THE DESIRED IDLE SPEED THROUGH A RANGE FROM 700 REVOLUTIONS PER MINUTE UP TO 1500 REVOLUTIONS PER MINUTE.
- ENGINE SPEED SHOULD FOLLOW THE COMMANDED IDLE SPEED. DOES IT?

NO

(2)
- DISCONNECT HARNESS CONNECTOR FROM THE IDLE AIR CONTROL VALVE, AND INSTALL HARNESS CONNECTOR INTO "NODE LIGHT" FROM TESTER KIT J 39763/CTI222DM.
- ENGINE RUNNING. USING TECH-1, COMMAND THE DESIRED IDLE SPEED THROUGH A RANGE UP AND DOWN.
- EACH NODE LIGHT SHOULD FLASH RED AND GREEN BUT NEVER "OFF."

DO THEY?

NO
- FAULTY CONNECTOR TERMINAL CONTACTS.
- OPEN CIRCUITS INCLUDING CONNECTORS.
- CIRCUITS SHORTED TO GROUND OR VOLTAGE.
- FAULTY ELECTRONIC CONTROL MODULE CONNECTIONS OR REPLACE ELECTRONIC CONTROL MODULE. REPAIR AS NECESSARY AND RETEST.

YES
- CHECK IDLE AIR CONTROL CONNECTIONS.
- CHECK IDLE AIR CONTROL PASSAGES.
- IF OK, REPLACE IDLE AIR CONTROL.

YES
- IGNITION "OFF."
- DISCONNECT THE HARNESS CONNECTOR FROM THE IDLE AIR CONTROL VALVE.
- USING THE DIGITAL VOLT OHM AMP MULTIMETER J 39689, CHECK RESISTANCE ACROSS IDLE AIR CONTROL VALVE COILS.
- SHOULD BE 40 TO 80 OHMS BETWEEN IDLE AIR CONTROL VALVE TERMINALS "A" TO "B", AND "C" TO "D".

OK
- CHECK RESISTANCE BETWEEN IDLE AIR CONTROL VALVE TERMINALS "B" AND "C" AND "A" AND "D".
- SHOULD BE INFINITE, NO CONTINUITY, OPEN CIRCUIT.

NOT OK

REPLACE IDLE AIR CONTROL VALVE AND RETEST.

OK

IDLE AIR CONTROL VALVE AND CIRCUIT ARE OK CIRCUIT OK. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

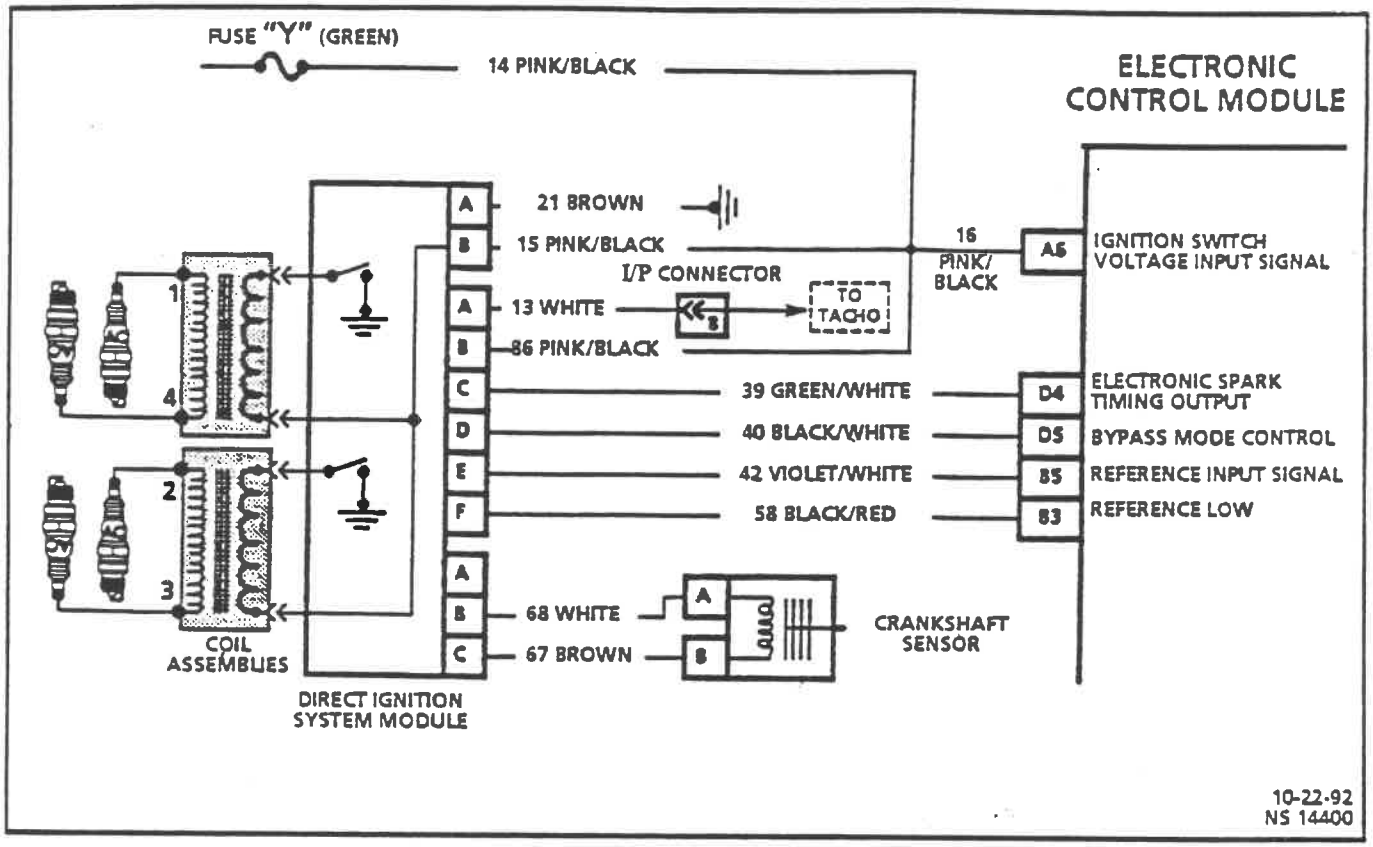
NOT OK

REPLACE IDLE AIR CONTROL VALVE AND RETEST.

AFTER ALL IDLE AIR CONTROL TESTING IS COMPLETE, RESET THE IDLE AIR CONTROL VALVE. CONNECT TECH 1, SELECT "MISC. TESTS," THEN "IDLE SYSTEM," THEN "IDLE RESET."

"AFTER REPAIRS." START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

3-9-93
NS 14378



CODE 42

ELECTRONIC SPARK TIMING CONTROL CIRCUIT PROBLEM 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

Code 42 will set if the electronic control module detects an improper signal on either the bypass mode control circuit 40 Black/White wire or the electronic spark timing output circuit 39 Green/White wire when the engine is cranking or while running. Review the general description of the ignition system in Section 1.4.

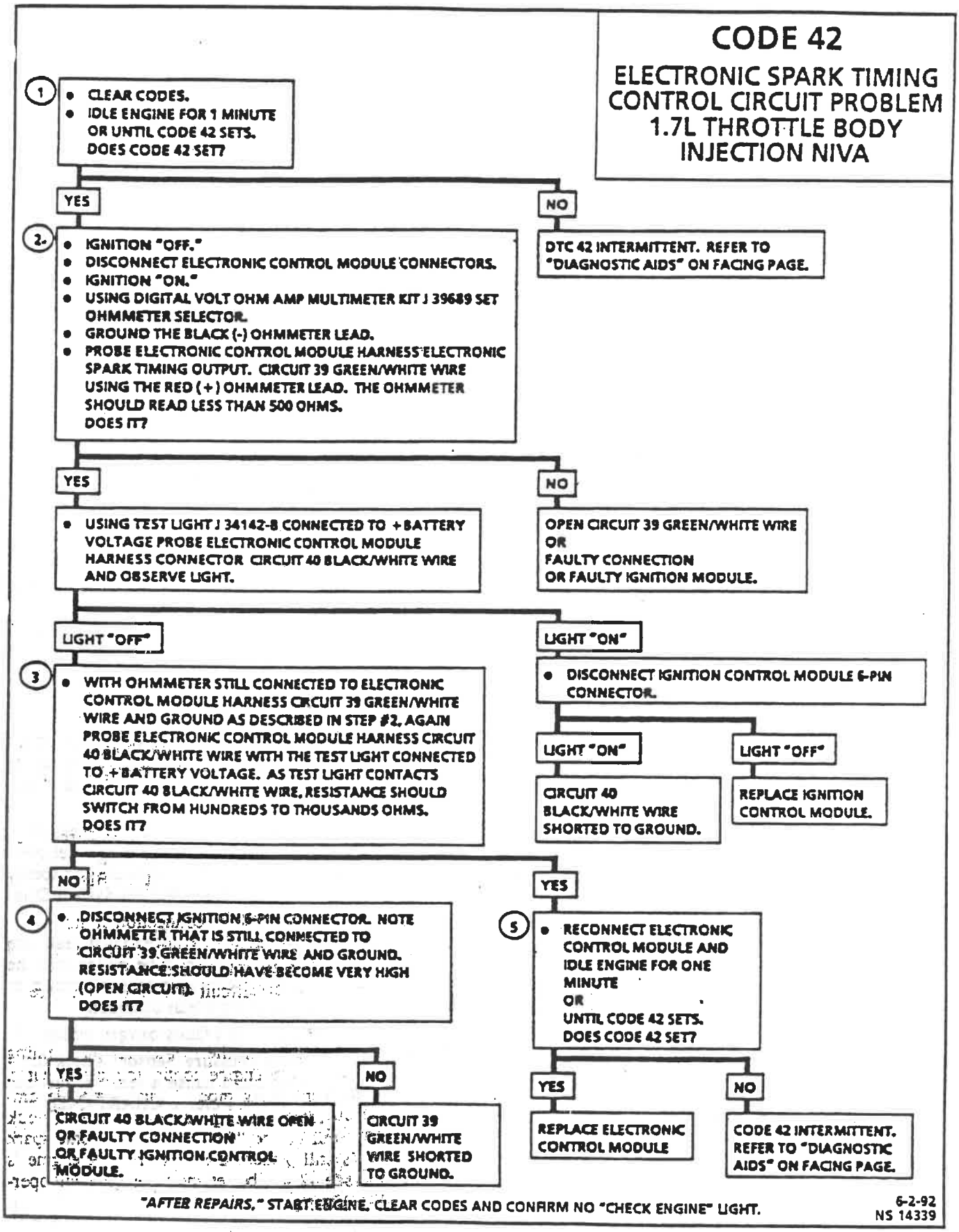
Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

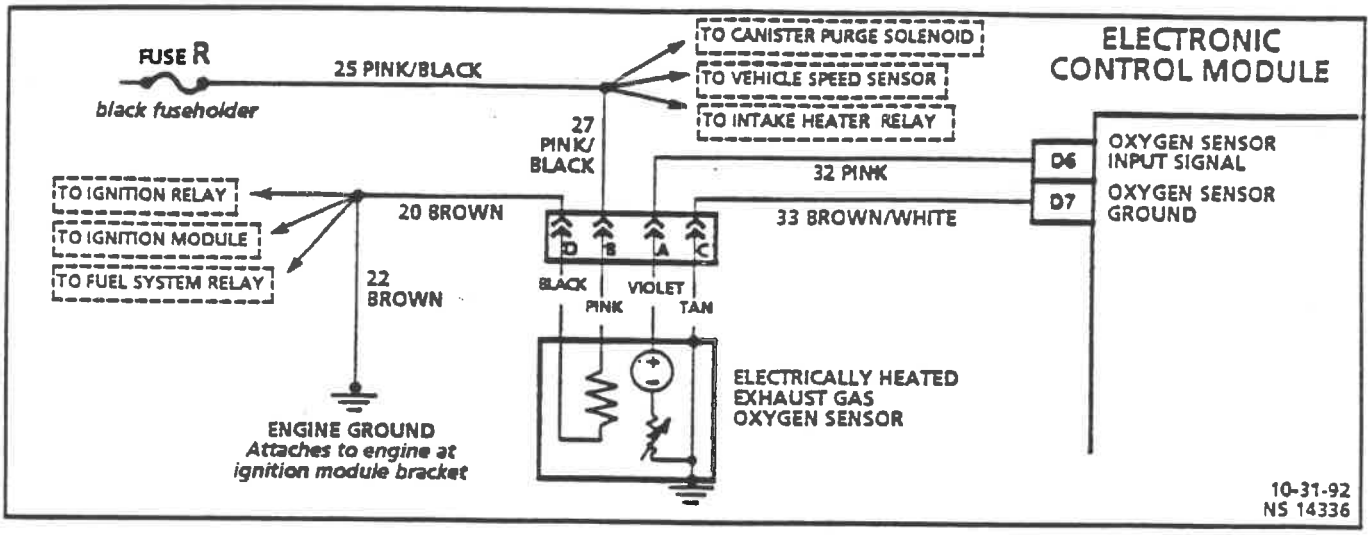
1. Code 42 means the electronic control module has seen an open or short to ground in the electronic spark timing output or bypass mode control circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Checks for a normal electronic spark timing ground path through the ignition module. An electronic spark timing Circuit 39 Green/White wire shorted to ground will also read less than 500 ohms; however, this will be checked later.
3. As the test light voltage touches Circuit 40 Black/White wire, the module should switch, causing the ohmmeter to "switch ranges," if the meter is in the low ohms position. The important thing is that the module "switched" above 500 ohms.
4. The ignition module did not switch and this step checks for:
   - Electronic spark timing output Circuit 39 Green/White wire shorted to ground.
   - Bypass mode control Circuit 40 Black/White wire open.
   - Faulty ignition module connection or module.
5. Confirms that Code 42 is a faulty electronic control module and not an intermittent in Circuits 39 Green/White wire or Circuit 40 Black/White wire.

Diagnostic Aids:

An open or ground in the electronic spark timing circuit will result in the engine continuing to run, but in a "bypass" ignition timing mode (ignition module timing) at a calculated timing value and the "Check Engine" light will not be "ON." If the electronic spark timing fault is still present the next time the engine is restarted, a Code 42 will be set and the engine will operate in module timing.

If Code 42 is intermittent, refer to Section "2.9B".


CODE 42
ELECTRONIC SPARK TIMING CONTROL CIRCUIT PROBLEM 1.7L THROTTLE BODY INJECTION NIVA
1
• CLEAR CODES.
• IDLE ENGINE FOR 1 MINUTE OR UNTIL CODE 42 SETS. DOES CODE 42 SET?
YES
NO
DTC 42 INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
2.
• IGNITION "OFF."
• DISCONNECT ELECTRONIC CONTROL MODULE CONNECTORS.
• IGNITION "ON."
• USING DIGITAL VOLT OHM AMP MULTIMETER KIT J 39689 SET OHMMETER SELECTOR.
• GROUND THE BLACK (-) OHMMETER LEAD.
• PROBE ELECTRONIC CONTROL MODULE HARNESS ELECTRONIC SPARK TIMING OUTPUT. CIRCUIT 39 GREEN/WHITE WIRE USING THE RED (+) OHMMETER LEAD. THE OHMMETER SHOULD READ LESS THAN 500 OHMS. DOES IT?
YES
NO
• USING TEST LIGHT J 34142-B CONNECTED TO +BATTERY VOLTAGE PROBE ELECTRONIC CONTROL MODULE HARNESS CONNECTOR CIRCUIT 40 BLACK/WHITE WIRE AND OBSERVE LIGHT.
OPEN CIRCUIT 39 GREEN/WHITE WIRE OR FAULTY CONNECTION OR FAULTY IGNITION MODULE.
LIGHT "OFF"
LIGHT "ON"
3
• WITH OHMMETER STILL CONNECTED TO ELECTRONIC CONTROL MODULE HARNESS CIRCUIT 39 GREEN/WHITE WIRE AND GROUND AS DESCRIBED IN STEP #2, AGAIN PROBE ELECTRONIC CONTROL MODULE HARNESS CIRCUIT 40 BLACK/WHITE WIRE WITH THE TEST LIGHT CONNECTED TO +BATTERY VOLTAGE. AS TEST LIGHT CONTACTS CIRCUIT 40 BLACK/WHITE WIRE, RESISTANCE SHOULD SWITCH FROM HUNDREDS TO THOUSANDS OHMS. DOES IT?
• DISCONNECT IGNITION CONTROL MODULE 6-PIN CONNECTOR.
LIGHT "ON"
LIGHT "OFF"
CIRCUIT 40 BLACK/WHITE WIRE SHORTED TO GROUND.
REPLACE IGNITION CONTROL MODULE.
NO
YES
4
• DISCONNECT IGNITION 6-PIN CONNECTOR. NOTE OHMMETER THAT IS STILL CONNECTED TO CIRCUIT 39 GREEN/WHITE WIRE AND GROUND. RESISTANCE SHOULD HAVE BECOME VERY HIGH (OPEN CIRCUIT). DOES IT?
5
• RECONNECT ELECTRONIC CONTROL MODULE AND IDLE ENGINE FOR ONE MINUTE OR UNTIL CODE 42 SETS. DOES CODE 42 SET?
YES
NO
CIRCUIT 40 BLACK/WHITE WIRE OPEN OR FAULTY CONNECTION OR FAULTY IGNITION CONTROL MODULE.
CIRCUIT 39 GREEN/WHITE WIRE SHORTED TO GROUND.
YES
NO
REPLACE ELECTRONIC CONTROL MODULE
CODE 42 INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
"AFTER REPAIRS," START ENGINE. CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.
6-2-92
NS 14339



CODE 44
LEAN EXHAUST INDICATION
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The electronic control module applies a reference voltage of about 450 millivolts between terminals "D7" and "D6". The oxygen sensor varies the voltage within a range of about 1 volt, if the exhaust is rich, down through about 10 millivolt, if exhaust is lean. A lean exhaust condition will cause the oxygen sensor to output a low voltage.

The sensor is like an open circuit and produces no voltage when it is below about 315°C. An open sensor circuit, or cold sensor, causes "Open Loop" operation.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

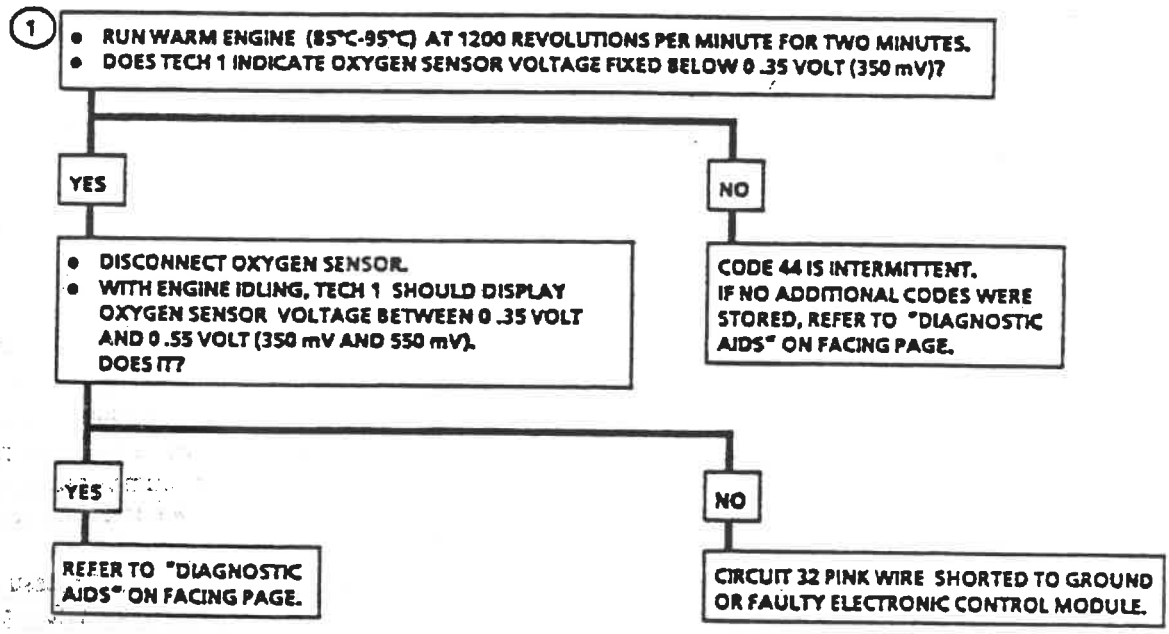
1. Code 44 is set if:
   - The fuel system is operating in "Closed Loop."
   - The oxygen sensor signal voltage on Circuit 32 Pink wire remains below 300 millivolts for 50 seconds.

Diagnostic Aids:

Using the Tech 1, observe the memory fuel adjustment values at different revolutions per minute and air flow conditions. The Tech 1 also displays the memory fuel adjustment cells, so the memory fuel adjustment values can be checked in each of the cells to determine when the Code 44 may have been set. If the conditions for Code 44 exist, the memory fuel adjustment values will be close to +50%.

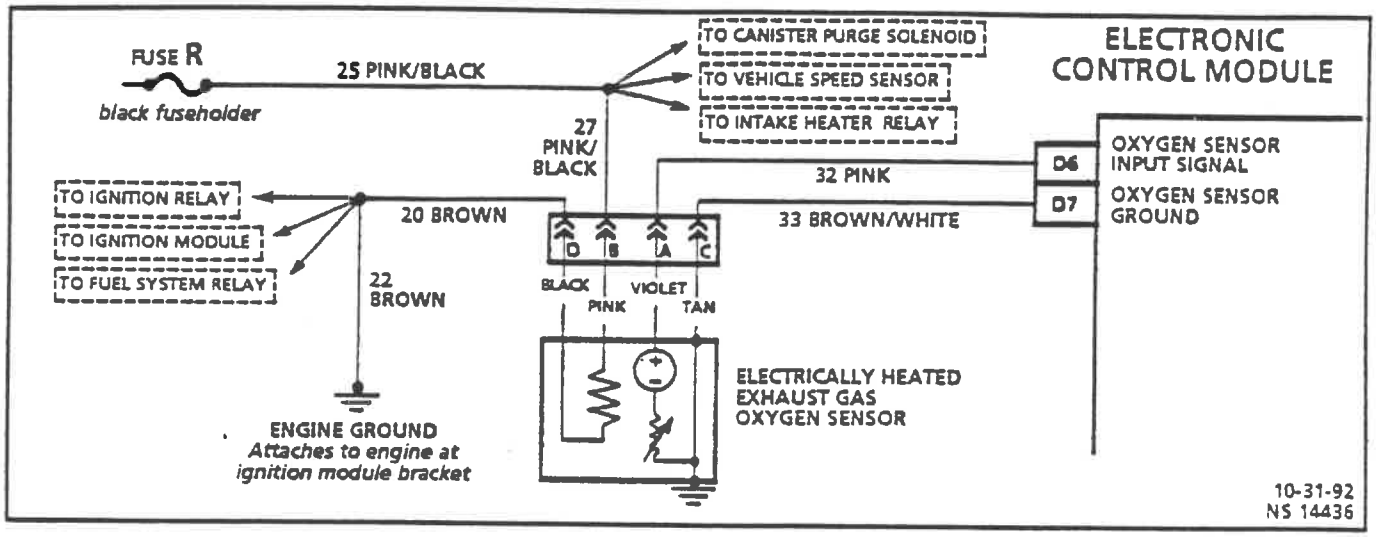
- Check for intermittent connection between connector and oxygen sensor.
- Poor connection at oxygen sensor ground wire.
- **Fuel Contamination:** Water, even in small amounts, near the in-tank fuel pump inlet can be delivered to the injector. The water causes a lean exhaust and can set a Code 44.
- **Fuel Pressure:** System will be lean if pressure is too low. It may be necessary to monitor fuel pressure while driving the vehicle at various road speeds and/or loads to confirm. Refer to Fuel System Diagnosis, CHART A-7.
- **Exhaust Leaks:** If there is an exhaust leak, the engine can cause outside air to be pulled into the exhaust leak and past the oxygen sensor. Vacuum or crankcase leaks can cause a lean condition.
- If the above are OK, it is a faulty oxygen sensor.
- **Manifold Absolute Pressure Sensor:** Check for a shifted sensor that could cause a lean exhaust but not set a Code 33 or 34. Refer to CHART C-1D.

CODE 44
LEAN EXHAUST INDICATION
1.7L THROTTLE BODY INJECTION NIVA


1
• RUN WARM ENGINE (85°C-95°C) AT 1200 REVOLUTIONS PER MINUTE FOR TWO MINUTES.
• DOES TECH 1 INDICATE OXYGEN SENSOR VOLTAGE FIXED BELOW 0 .35 VOLT (350 mV)?
YES
NO
• DISCONNECT OXYGEN SENSOR.
• WITH ENGINE IDLING, TECH 1 SHOULD DISPLAY OXYGEN SENSOR VOLTAGE BETWEEN 0 .35 VOLT AND 0 .55 VOLT (350 mV AND 550 mV).
DOES IT?
CODE 44 IS INTERMITTENT.
IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
YES
NO
REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
CIRCUIT 32 PINK WIRE SHORTED TO GROUND OR FAULTY ELECTRONIC CONTROL MODULE.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

5-27-92
NS 14438



CODE 45
RICH EXHAUST INDICATION
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The electronic control module applies a reference voltage of approximately 450 millivolts between terminals "D7" and "D6". The oxygen sensor varies the voltage within a range of about 1 volt, if the exhaust is rich, and down through about 10 millivolt, if exhaust is lean. A rich exhaust condition will cause the oxygen sensor to output a high voltage.

The sensor is like an open circuit and produces no voltage when it is below 315°C. An open sensor circuit, or a cold sensor causes "Open Loop" operation.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 45 is set if:
   - The fuel system is operating in "Closed Loop."
   - The oxygen sensor signal voltage on Circuit 32 Pink wire remains above 600 millivolts for 90 seconds.

Diagnostic Aids:

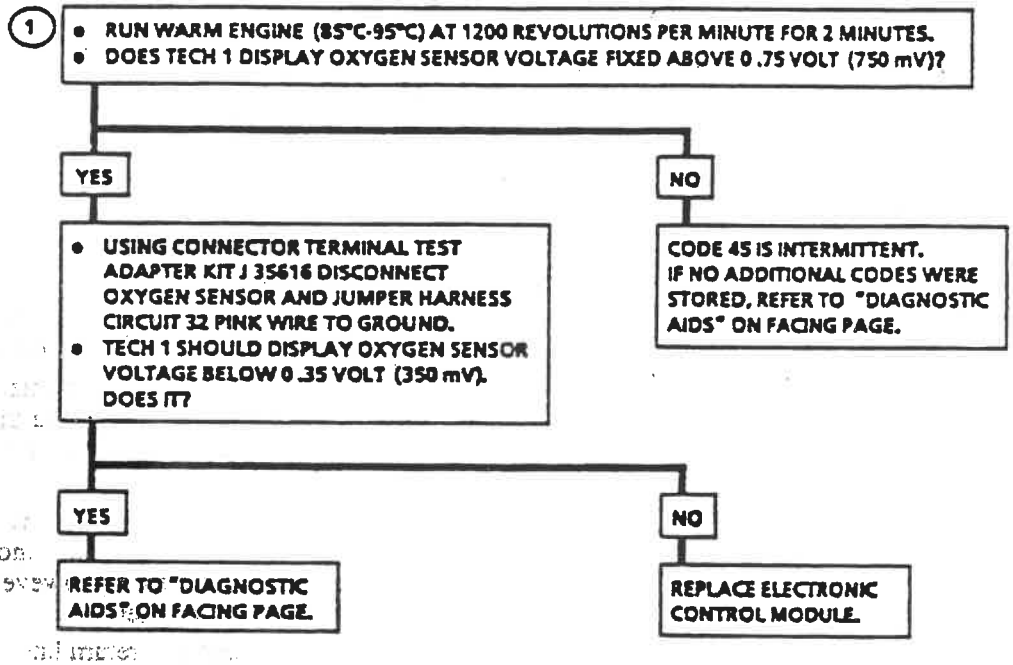
Using the Tech 1 "Scan" tool, observe the memory fuel adjustment values at different revolutions per minute and air flow conditions. The Tech 1 "Scan" tool also displays the memory fuel adjustment cells, so the memory fuel adjustment values can be checked in each of the cells to determine when the Code 45 may have been set. If the conditions for Code 45 exist, the memory fuel adjustment values will be close to -38.

- **Coolant Temperature Sensor:** Check for a shifted sensor that could cause a rich exhaust but not set Code 15, see Code 15 for sensor resistance values.
- **Throttle Position Sensor:** An intermittent throttle position sensor output will cause the system to go rich, due to a false indication of the engine accelerating. Refer to CHART C-1H.
- **Fuel Pressure:** System will go rich if pressure is too high. The electronic control module can compensate for some increase. However, if it gets too high, a Code 45 may be set.

  Check for a pinched fuel return line, or plugged vacuum hose to fuel pressure regulator. See Fuel System Diagnosis, CHART A-7.
- **Leaking Injector:** Refer to CHART A-7.

  Check for fuel contaminated oil.
- **Canister Purge:** Check for fuel saturation. If full of fuel, check canister control and hoses. Refer to CHART C-3.
- **Manifold Absolute Pressure Sensor:** Check for a shifted sensor that could cause a rich exhaust but not set a Code 33 or 34. Refer to CHART C-1D.

CODE 45
RICH EXHAUST INDICATION
1.7L THROTTLE BODY INJECTION NIVA

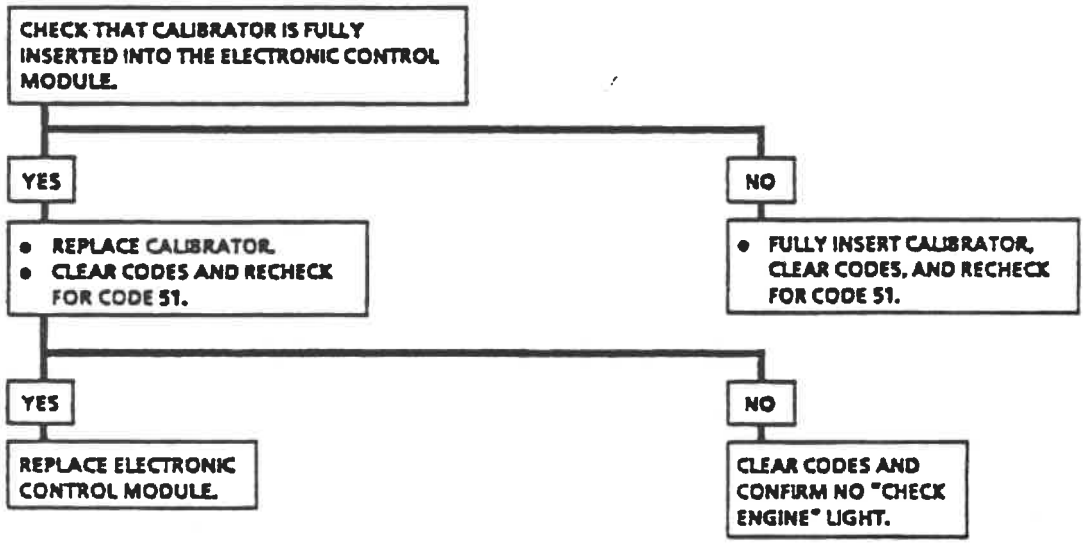

1
• RUN WARM ENGINE (85°C-95°C) AT 1200 REVOLUTIONS PER MINUTE FOR 2 MINUTES.
• DOES TECH 1 DISPLAY OXYGEN SENSOR VOLTAGE FIXED ABOVE 0 .75 VOLT (750 mV)?
YES
NO
• USING CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 DISCONNECT OXYGEN SENSOR AND JUMPER HARNESS CIRCUIT 32 PINK WIRE TO GROUND.
• TECH 1 SHOULD DISPLAY OXYGEN SENSOR VOLTAGE BELOW 0 .35 VOLT (350 mV). DOES IT?
CODE 45 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
YES
NO
REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
REPLACE ELECTRONIC CONTROL MODULE.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

6-2-92
NS 14439

CODE 51

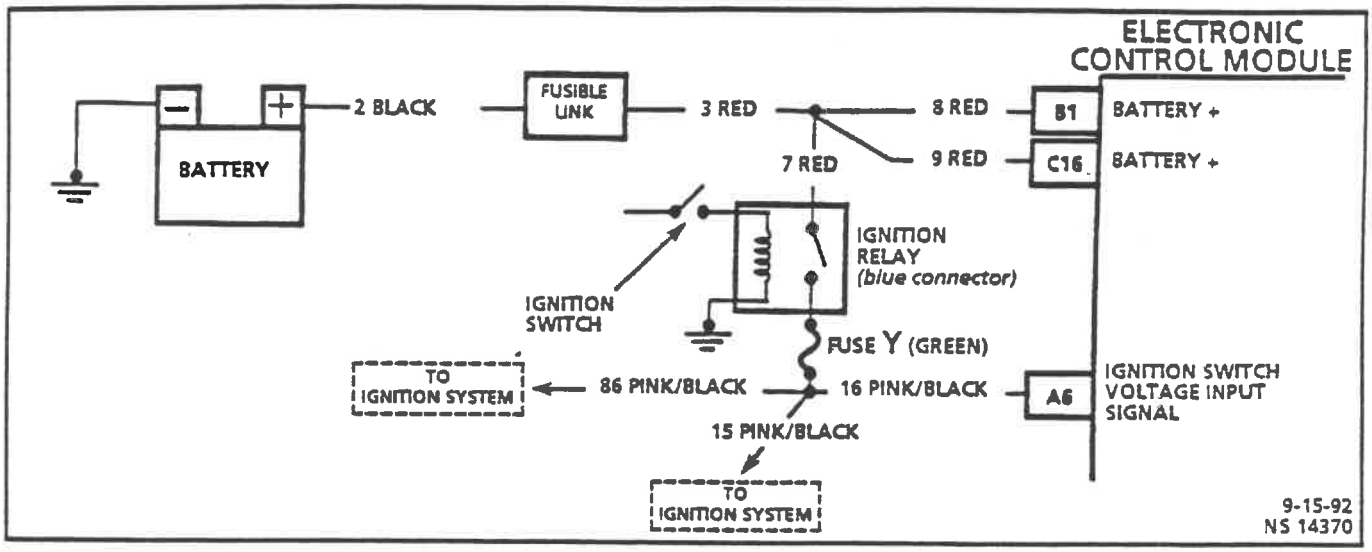
CALIBRATOR ERROR
1.7L THROTTLE BODY INJECTION NIVA


CHECK THAT CALIBRATOR IS FULLY INSERTED INTO THE ELECTRONIC CONTROL MODULE.
YES
NO
• REPLACE CALIBRATOR.
• CLEAR CODES AND RECHECK FOR CODE 51.
• FULLY INSERT CALIBRATOR, CLEAR CODES, AND RECHECK FOR CODE 51.
YES
NO
REPLACE ELECTRONIC CONTROL MODULE.
CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

5-27-92
NS 14443

BLANK



CODE 53

SYSTEM VOLTAGE TOO HIGH
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

Code 53 will set if the engine is running and the battery voltage is more than 16.9 volts for one second on electronic control module terminal "A6." During the time the fault is present, all electronic control module outputs will be disengaged and setting of additional codes may result.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

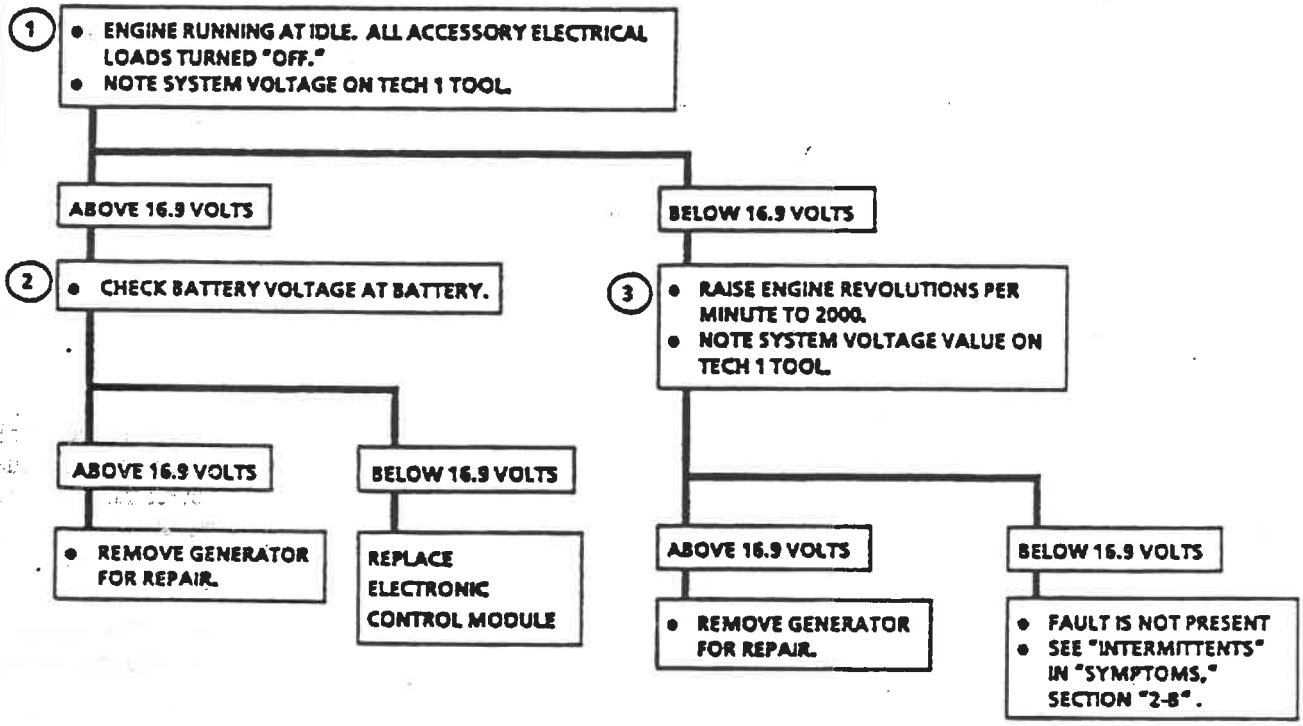
1. Normal battery output is between 12-15 volts..
2. Checks to see if the high voltage reading is due to the generator or incorrect interpretation by the electronic control module. With engine running, check voltage at the battery.
3. Checks to see if generator is faulty at higher engine speed.

Diagnostic Aids:

During the time the failure is present, all electronic control module outputs except the fuel injector and fuel system relay, will be disengaged to protect the hardware. The setting of additional codes may result.

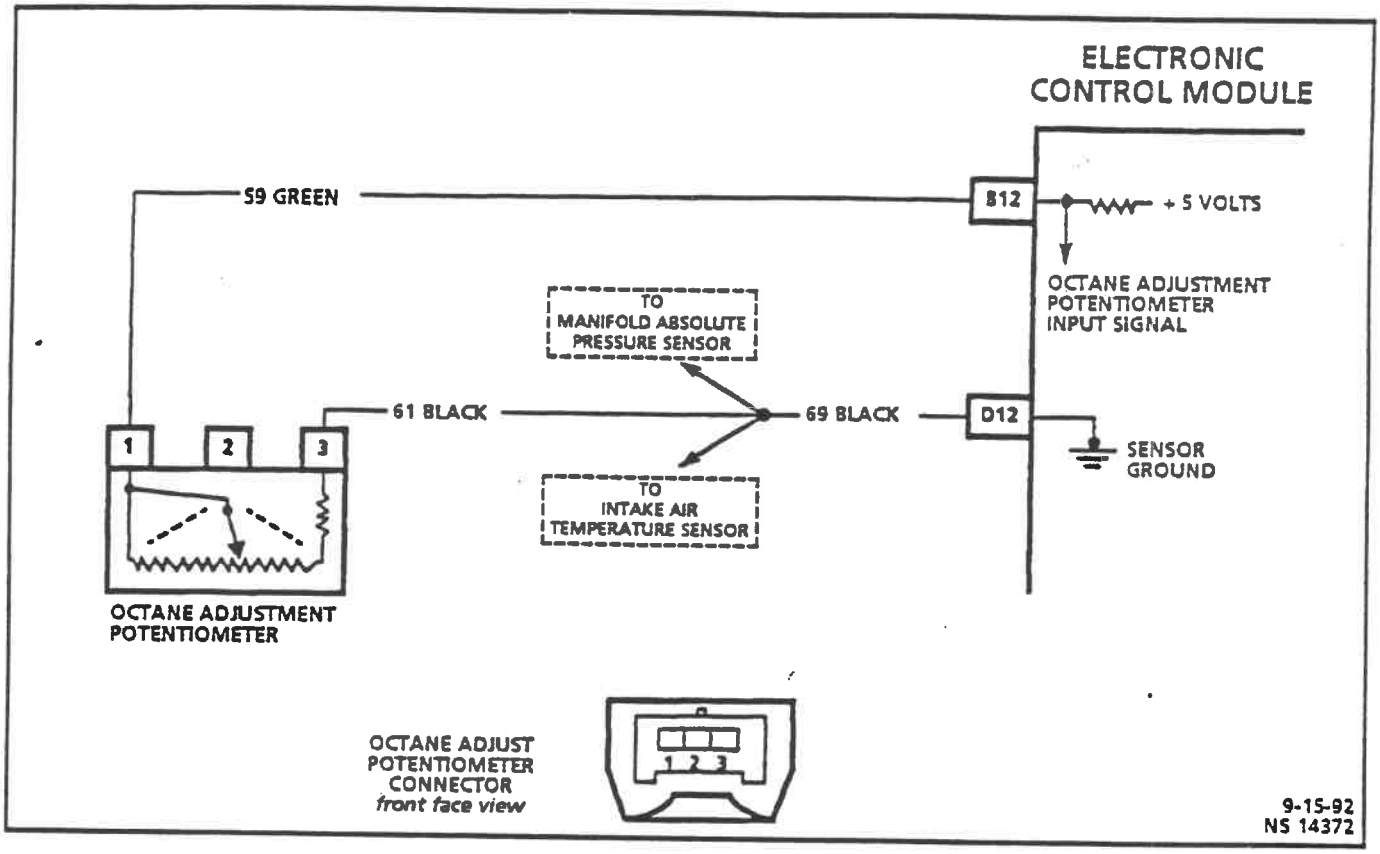
CODE 53

SYSTEM VOLTAGE TOO HIGH
1.7L THROTTLE BODY INJECTION NIVA


1
• ENGINE RUNNING AT IDLE. ALL ACCESSORY ELECTRICAL LOADS TURNED "OFF."
• NOTE SYSTEM VOLTAGE ON TECH 1 TOOL.
ABOVE 16.9 VOLTS
BELOW 16.9 VOLTS
2
• CHECK BATTERY VOLTAGE AT BATTERY.
3
• RAISE ENGINE REVOLUTIONS PER MINUTE TO 2000.
• NOTE SYSTEM VOLTAGE VALUE ON TECH 1 TOOL.
ABOVE 16.9 VOLTS
BELOW 16.9 VOLTS
• REMOVE GENERATOR FOR REPAIR.
REPLACE ELECTRONIC CONTROL MODULE
ABOVE 16.9 VOLTS
BELOW 16.9 VOLTS
• REMOVE GENERATOR FOR REPAIR.
• FAULT IS NOT PRESENT
• SEE "INTERMITTENTS" IN "SYMPTOMS," SECTION "2-8".

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

6-2-92
NS 14371



CODE 54

(Page 1 of 2)

OCTANE ADJUSTMENT (SIGNAL VOLTAGE TOO HIGH OR TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The octane adjustment potentiometer provides a voltage that changes with an adjustment screw. The voltage is adjustable from about 1 volt to about 4.7 volts. The engine must be running to allow the Tech 1 to read this voltage correctly.

The octane adjustment voltage acts as an ignition timing spark retard which allows for adjustments when low octane fuel produces spark knock.

Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 54 will set if:
   - The octane adjustment signal voltage is less than 0.5 volts or greater than 4.9 volts for approximately 2 seconds.
2. With the octane adjust potentiometer disconnected from the electronic control module the Tech 1 should read close to 5 volts.

Diagnostic Aids:

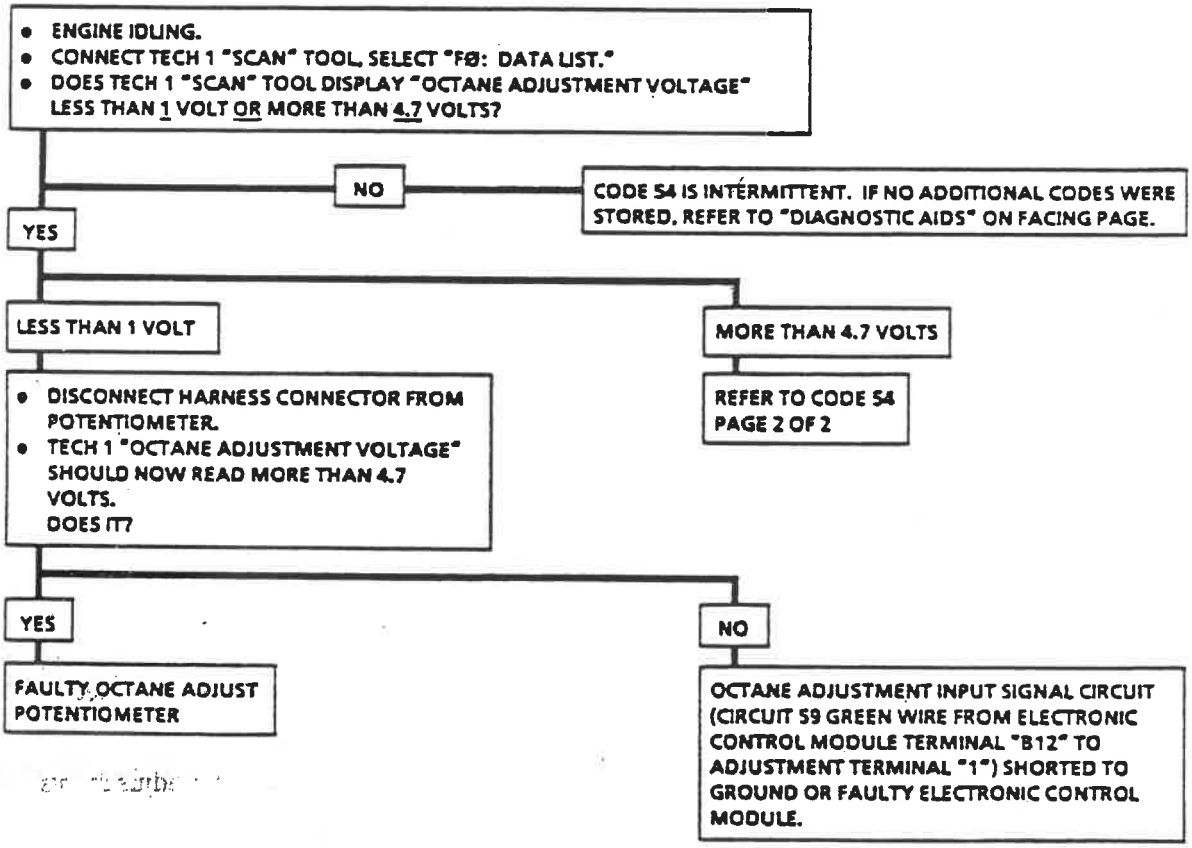
An open or short to ground in the octane adjustment circuit wires will result in a Code 54, and/or Code 23, Code 33.

Refer to "Intermittents" in "Symptoms," Section "2.9B."

CODE 54

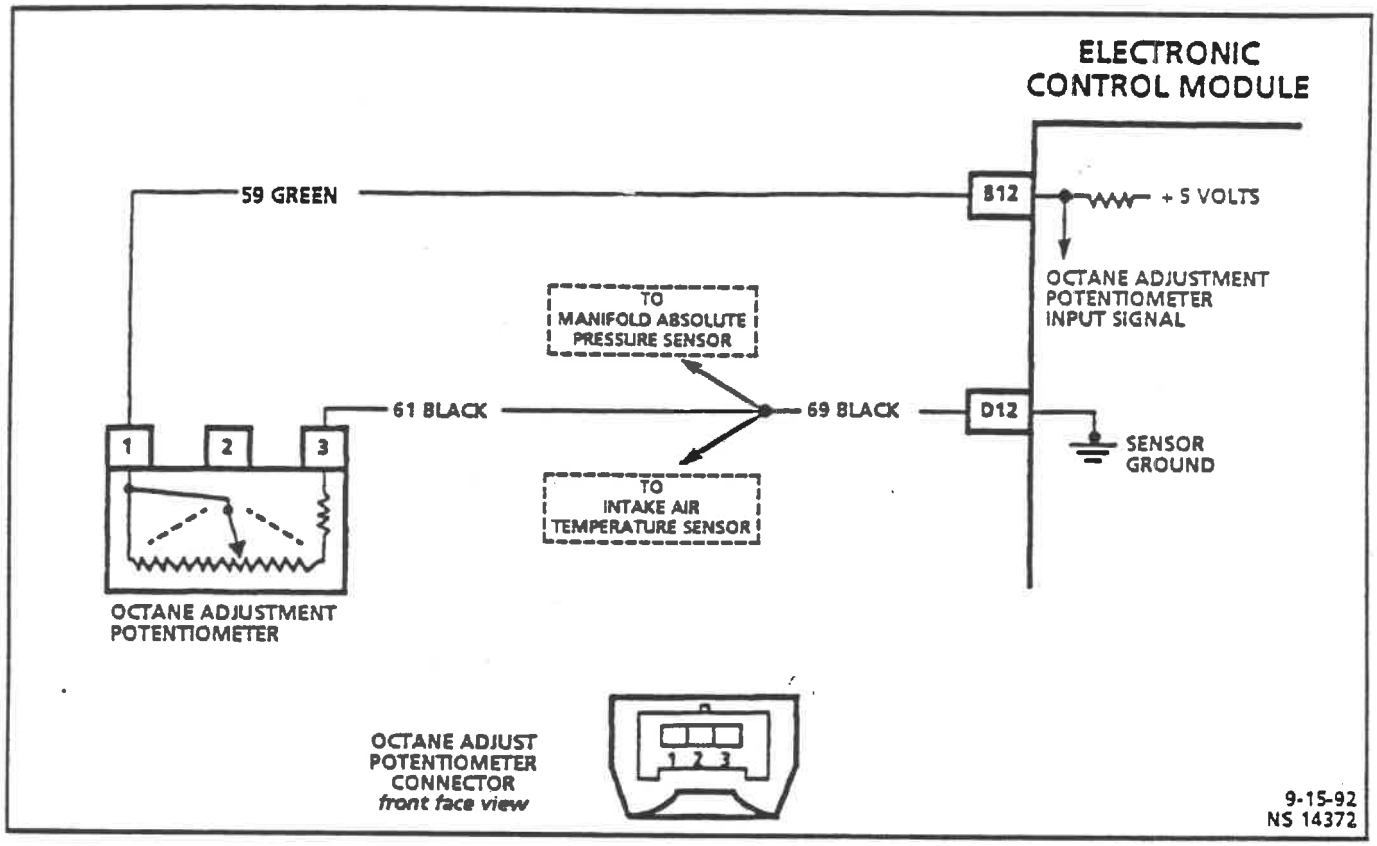
(Page 1 of 2)

OCTANE ADJUSTMENT (SIGNAL VOLTAGE TOO HIGH OR TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA


• ENGINE IDLING.
• CONNECT TECH 1 "SCAN" TOOL, SELECT "F0: DATA LIST."
• DOES TECH 1 "SCAN" TOOL DISPLAY "OCTANE ADJUSTMENT VOLTAGE" LESS THAN 1 VOLT OR MORE THAN 4.7 VOLTS?
NO
CODE 54 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
YES
LESS THAN 1 VOLT
MORE THAN 4.7 VOLTS
• DISCONNECT HARNESS CONNECTOR FROM POTENTIOMETER.
• TECH 1 "OCTANE ADJUSTMENT VOLTAGE" SHOULD NOW READ MORE THAN 4.7 VOLTS.
DOES IT?
REFER TO CODE 54 PAGE 2 OF 2
YES
NO
FAULTY OCTANE ADJUST POTENTIOMETER
OCTANE ADJUSTMENT INPUT SIGNAL CIRCUIT (CIRCUIT 59 GREEN WIRE FROM ELECTRONIC CONTROL MODULE TERMINAL "B12" TO ADJUSTMENT TERMINAL "1") SHORTED TO GROUND OR FAULTY ELECTRONIC CONTROL MODULE.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

2-5-93
NS 14373



CODE 54

(Page 2 of 2)

OCTANE ADJUSTMENT (SIGNAL VOLTAGE TOO HIGH OR TOO LOW) 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The octane adjustment potentiometer provides a voltage that changes with an adjustment screw. The voltage is adjustable from about 1 volt to about 4.7 volts. The engine must be running to allow the Tech 1 to read this voltage correctly.

The octane adjustment voltage acts as an ignition timing spark retard ratio trim pot which allows for adjustments when low octane fuel produces spark knock.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

3. This step checks for a short to voltage or a potentially bad octane adjust potentiometer.
4. This step checks for an open ground circuit between the electronic control module and octane adjust potentiometer terminal "3".
5. This will determine if there is an open in the input signal wire, faulty connections or a potentially bad electronic control module.

CODE 54

(Page 2 of 2)
OCTANE ADJUSTMENT
(SIGNAL VOLTAGE TOO HIGH OR TOO LOW)
1.7L THROTTLE BODY INJECTION NIVA

CONTINUED FROM CODE 54 PAGE 1 OF 2

TECH 1 DISPLAYS "OCTANE ADJUSTMENT VOLTAGE" ABOVE 4.7 VOLTS.

- DISCONNECT HARNESS CONNECTOR FROM OCTANE ADJUST POTENTIOMETER.
- USING CONNECTOR TERMINAL TEST ADAPTER KIT J 35616, CONNECT HARNESS TERMINALS "1" AND "3" TOGETHER.
- ENGINE IDLING.
- TECH 1 SHOULD NOW DISPLAY "OCTANE ADJUSTMENT VOLTAGE" LESS THAN 1 VOLT.
  DOES IT?

(3)

NO (4)

- REMOVE JUMPER WIRE FROM BETWEEN OCTANE ADJUST POTENTIOMETER HARNESS TERMINALS "1" AND "3".
- USING CONNECTOR TEST ADAPTER KIT J 35616, CONNECT OCTANE ADJUST POTENTIOMETER HARNESS TERMINAL "1" TO GROUND. (CIRCUIT 59 GREEN WIRE.)
- ENGINE IDLING.
- TECH 1 SHOULD NOW DISPLAY "OCTANE ADJUSTMENT VOLTAGE" LESS THAN 1 VOLT.
  DOES IT?

YES

CHECK FOR SHORT CIRCUIT TO ALTERNATIVE VOLTAGE SOURCE ON INPUT SIGNAL WIRE (CIRCUIT 59 GREEN WIRE BETWEEN ELECTRONIC CONTROL MODULE AND "OCTANE ADJUST POTENTIOMETER HARNESS TERMINAL "1" AND ELECTRONIC CONTROL MODULE TERMINAL "B12"). IF NONE FOUND REPLACE OCTANE ADJUST POTENTIOMETER AND RETEST. SEE SECTION 3.1 FOR REPLACE AND ADJUST PROCEDURE.

NO (5)

- AT ELECTRONIC CONTROL MODULE BACKPROBE CONNECTOR "B12" WITH A TEST LIGHT CONNECTED TO GROUND. LEAVE TEST LIGHT IN PLACE WHILE OBSERVING TECH 1 DISPLAY.
- ENGINE IDLING.
- TECH 1 SHOULD NOW DISPLAY "OCTANE ADJUSTMENT VOLTAGE" LESS THAN 1 VOLT.
  DOES IT?

YES

REPAIR OPEN SENSOR GROUND CIRCUIT (BLACK WIRE) BETWEEN ELECTRONIC CONTROL MODULE TERMINAL "D2" AND OCTANE ADJUST POTENTIOMETER HARNESS CONNECTOR TERMINAL "3".

NO

FAULTY CONNECTIONS
OR
FAULTY ELECTRONIC CONTROL MODULE.

YES

REPAIR OPEN CIRCUIT IN INPUT SIGNAL WIRE (CIRCUIT 59 GREEN WIRE) BETWEEN TERMINAL "B12" AND OCTANE ADJUST POTENTIOMETER HARNESS TERMINAL "1".

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

2-8-93
NS 15695

CODE 55
ELECTRONIC CONTROL MODULE ERROR

FAULTY ELECTRONIC CONTROL MODULE.

REPLACE ELECTRONIC CONTROL MODULE

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

5-27-92
NS 14981

SECTION 2.9B

SYMPTOM CHARTS

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IMPORTANT PRELIMINARY CHECKS

- Before using this section you should have performed the "Diagnostic Circuit Check."
- Verify the customer complaint, and locate the correct symptom. Check the items indicated under that symptom.
- If the ENGINE CRANKS BUT WILL NOT RUN, use CHART A-3.
- Several of the following symptom procedures call for a careful visual/physical check.

The importance of this step cannot be stressed too strongly—it can lead to correcting a problem without further checks and can save valuable time.

BEFORE STARTING

This check should include:

- Electronic control module grounds for being clean, tight, and in their proper location.
- Vacuum hoses for splits, kinks and proper connections. Check thoroughly for any type of leak or restriction.
- Air leaks at throttle body mounting area and intake manifold sealing surfaces (also check intake manifold Electric Heater's mounting bolts for proper tightness).
- Ignition wires for cracking, hardness, proper routing and carbon tracking.
- Wiring for proper connections, pinches, and cuts.

  If wiring harness or connector repair is necessary, refer to "Service Operations," Section "3" for correct procedure.

INTERMITTENTS

(Page 1 of 2)

Definition: Problem may or may not turn "ON" the "Check Engine" light, or store a code.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms," in this section.

DIAGNOSTIC CODE CHARTS IN "DIAGNOSTIC CHARTS," SECTION "2.9-A"

- DO NOT use the Diagnostic Code Charts in "Diagnostic Charts," Section "2.9-A" for intermittent problems. The fault must be present to locate the problem. If a fault is intermittent, use of diagnostic code charts may result in replacement of good parts.

FAULTY ELECTRICAL CONNECTIONS OR WIRING

- Most intermittent problems are caused by faulty electrical connections or wiring. Perform a careful check of suspect circuits for:
  - Poor mating of the connector halves, or terminals, not fully seated in the connector body (backed out).
  - Improperly formed or damaged terminals. All connector terminals in problem circuit should be carefully reformed or replaced to insure proper contact tension.
  - Poor terminal to wire connection. This requires removing the terminal from the connector body to check. See "Service Operations" Section "3," "Wiring Harness Service."

ROAD TEST

- If a visual/physical check does not find the cause of the problem, the vehicle can be driven with a voltmeter connected to a suspected circuit or a Tech 1 "Scan" tool may be used. An abnormal voltage or Tech 1 "Scan" tool reading when the problem occurs indicates the problem may be in that circuit.

  The Tech 1 "Scan" tool has a special mode called "snapshot." This snapshot mode can be used to capture electronic control module serial data when a problem occurs, so that the technician can play back the data one event at a time to look for erroneous data when the fault occurred. For more information on the snapshot mode, refer to the Tech 1 operator's manual.

INTERMITTENTS

(Page 2 of 2)

Definition: Problem may or may not turn "ON" the "Check Engine" light, or store a code.

INTERMITTENT "CHECK ENGINE" LIGHT

- As intermittent "Check Engine" light, and No Diagnostic Codes, may be caused by:
  - Electrical system interference caused by a defective relay, electronic control module driven solenoid, or switch. They can cause a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
  - Improper installation of electrical options, such as lights, 2-way radios, etc.
  - Electronic spark timing wires not properly routed away from spark plug wires, ignition system components and generator.
  - Ignition secondary shorted to ground.
  - "Check Engine" light circuit or diagnostic "test" terminal circuit intermittently shorted to ground.
  - Electronic control module grounds not clean, tight, and in their proper location. These ground wires secure to the engine block on the direct ignition system bracket uppermost bolt. This bolt was previously used to retain the distributor on a carbureted engine.

LOSS OF DIAGNOSTIC CODE MEMORY

- To check, disconnect throttle position sensor and idle engine until "Check Engine" light comes "ON." Code 22 should be stored and kept in memory, when the ignition is turned "OFF" longer than 10 seconds. If Code 22 is not stored, the electronic control module is faulty.

HARD START

(Page 1 of 2)

Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms," in this section.
- Make sure the driver is using the correct starting procedure. This includes depressing and holding the clutch pedal down while cranking to start. When starting the engine at very cold temperatures of below -10°C, the accelerator pedal should be held down 1/4 of the way while cranking to start, as well as depressing the clutch pedal.

SENSORS

- **CHECK:** Coolant temperature sensor—Using a Tech 1 "Scan" tool, compare coolant temperature with ambient temperature on a cold engine.
  - If coolant temperature reading is 2°C greater than or less than ambient air temperature on a cold engine, check for high resistance in coolant sensor circuit or sensor itself. Compare resistance value to the "Diagnostic Aids" chart on the Code 14 or Code 15 chart.
- **CHECK:** Throttle position sensor—use CHART C-1H.
- **CHECK:** Manifold absolute pressure sensor—use CHART C-1D.

FUEL SYSTEM

- **CHECK:** In-line fuel filter. Replace if dirty or plugged.
- **CHECK:** For poor quality fuel.
- **CHECK:** Fuel pressure, use CHART A-7.
- **CHECK:** For contaminated fuel.
- **CHECK:** Fuel system relay—Connect test light between fuel pump "test" terminal and ground. Test light should be "ON" for 2 seconds following ignition "ON," after ignition switch has been "OFF" for at least 10 seconds. If not OK, use CHART A-5.
- **CHECK:** Operation of intake manifold electrical heater (see: CHART C-9).

IGNITION SYSTEM

- **CHECK:** Ignition system for:
  - Proper ignition voltage output with spark tester J 26792 (ST-125).
  - Spark plugs, wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits.
  - Crankshaft sensor resistance and connections.
  - Spark plug leads/wires for excessive resistance.
  - Bare and shorted wires.
  - Loose ignition coil connections.
- **CHECK:** Electronic spark timing output circuit for short to ground.

HARD START

(Page 2 of 2)

Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

ADDITIONAL CHECKS

- **CHECK:** Idle air control operation, use CHART C-2C.
- **CHECK:** For correct engine calibrator (see "Service Bulletins").

CRANKING AND CHARGING SYSTEMS, AND CONDITION OF BATTERY

- **CHECK:** For low cranking speeds that can cause difficult starting. Use the Tech 1 "Scan" tool in the "Miscellaneous Tests" - "Crank Tests" mode to monitor cranking speed information.

SURGES AND/OR CHUGGLES

Definition: Engine power variation, under steady throttle or cruise. Feels like the vehicle speeds up and slows down, with no change in the accelerator pedal.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms," in this section.
- Be sure driver understands air conditioning compressor operation in owner's manual.
- Use a Tech 1 "Scan" tool to make sure reading of vehicle speed sensor matches vehicle speedometer.

FUEL SYSTEM

- **CHECK:** Fuel pressure while condition exists, use CHART A-7.
- **CHECK:** In-line fuel filter. Replace if dirty or plugged.

IGNITION SYSTEM

- **CHECK:** For proper ignition system voltage output using spark tester J 26792 (ST-125).
- **CHECK:** Spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- **CHECK:** For misfire under load. Use CHART C-4C.

ADDITIONAL CHECKS

- **CHECK:** Electronic control module grounds for being clean, tight, and in their proper locations. These ground wires secure to the engine block on the direct ignition system bracket uppermost bolt. This bolt was previously used to retain the distributor on a carbureted engine.
- **CHECK:** Alternator output voltage. Repair if less than 9 or more than 16.9 volts.
- **CHECK:** Vacuum lines for kinks or leaks.

LACK OF POWER, SLUGGISH, OR SPONGY

(Page 1 of 2)

Definition: Engine delivers less than expected power. Little or no increase in speed, when accelerator pedal is pushed down part way.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms," in this section.
- Compare customer's vehicle to similar unit. Make sure the customer has an actual problem.
- Remove air filter and check air filter for dirt, or for being plugged, replace as necessary.

FUEL SYSTEM

- **CHECK:** For contaminated fuel.
- **CHECK:** For restricted fuel filter, or improper fuel pressure, use CHART A-7.

IGNITION SYSTEM

- **CHECK:** Proper ignition system voltage output with spark tester J 26792 (ST-125).
- **CHECK:** Ignition timing.
- **CHECK:** Proper operation of electronic spark timing.

EXHAUST SYSTEM

- **CHECK:** Exhaust system for possible restriction: Use CHART B-1.

SENSORS

- **CHECK:** Manifold absolute pressure sensor. Use CHART C-1D. Vacuum hose between engine and manifold absolute pressure sensor for kinks or leaks.

LACK OF POWER, SLUGGISH, OR SPONGY

(Page 2 of 2)

Definition: Engine delivers less than expected power. Little or no increase in speed, when accelerator pedal is pushed down part way.

ENGINE MECHANICAL

- **CHECK:** Engine compression. Refer to Engine Manual.
- **CHECK:** Engine valve timing. Refer to Engine Manual.
- **CHECK:** Engine for proper or worn camshaft. Refer to Engine Manual.

ADDITIONAL CHECKS

- **CHECK:** Electronic control module grounds for being clean, tight, and in their proper location. These ground wires secure to the engine block on the direct ignition system bracket uppermost bolt.
- **CHECK:** Air conditioning operation. Air conditioning clutch should cut out at wide open throttle.
- **CHECK:** Alternator output voltage. Repair if less than 9 or more than 16.9 volts.

DETONATION/SPARK KNOCK

(Page 1 of 2)

Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

PRELIMINARY CHECKS

- Perform the careful physical/visual checks as described at start of "Symptoms," in this section.
- Make sure the customer has an actual problem.
- Remove air filter and check air filter for dirt, or for being plugged, replace as necessary.

COOLING SYSTEM

- **CHECK:** For obvious overheating problems.
- **CHECK:** Low engine coolant.
- **CHECK:** Loose water pump belt.
- **CHECK:** Restricted air flow to radiator, or restricted water flow thru radiator.
- **CHECK:** Faulty or incorrect thermostat.
- **CHECK:** Correct coolant solution.

SENSOR

- **CHECK:** Coolant temperature sensor, which may have shifted in value.
  Compare coolant temperature sensor resistance to the "Diagnostic Aids" chart on Code 14 or Code 15 chart.

FUEL SYSTEM

- **CHECK:** Fuel pressure, use CHART A-7.
- **CHECK:** For poor fuel quality, proper octane rating.

NOTICE: If Tech 1 "Scan" tool readings are normal (see TECH 1 "SCAN" TOOL TYPICAL DATA VALUE list) and there are no engine mechanical faults, fill fuel tank with a fresh and proper fuel for vehicle and evaluate vehicle performance.

OCTANE ADJUSTMENT POTENTIOMETER

- As built at the factory this adjustment was initially set for premium octane fuel. If low octane fuel is to be used on a regular basis, it is advisable to readjust the octane adjustment potentiometer. Use CHART C-15.

THERMOSTATIC AIR CLEANER

- Ensure that the thermostatic air cleaner functions properly. Check that the temperature actuated damper moves away from "HOT AIR" position after the engine is fully warmed up. Use the Tech 1 "Scan" tool to observe intake air temperature after the engine is fully warmed up. At road speeds the intake air temperature should be close to ambient air temperature.

DETONATION/SPARK KNOCK

(Page 2 of 2)

Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

IGNITION SYSTEM

- **CHECK:** Spark plugs for proper heat range.

ENGINE MECHANICAL

- **CHECK:** For carbon buildup.
- **CHECK:** For incorrect basic engine parts such as cam, heads, pistons, etc.
- **CHECK:** For excessive oil entering combustion chamber.

ADDITIONAL CHECKS

- **CHECK:** For correct engine calibrator (see Service Bulletins).
- **CHECK:** For intake manifold electric heater should be "OFF" with the engine fully warmed up. Use Tech 1 to display "MANIFOLD HEATER" "ON/OFF" status.

HESITATION, SAG, STUMBLE

Definition: Momentary lack of response as the accelerator is pushed down. Can occur at all vehicle speeds. Usually most severe when first trying to make the vehicle move, as from a stop sign. May cause the engine to stall if severe enough.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms," in this section.

SENSORS

- **CHECK:** Throttle position sensor. Use CHART C-1H.
- **CHECK:** Manifold absolute pressure sensor response and accuracy. Use CHART C-1D.
- **CHECK:** For kinked or leaking vacuum hose between engine and manifold absolute pressure sensor.

IGNITION SYSTEM

- **CHECK:** Spark plug wires for being faulty.
- **CHECK:** Spark plugs for being fouled.
- **CHECK:** Open ignition system ground, reference low circuit.

EVAPORATIVE EMISSIONS

- **CHECK:** Evaporative emissions storage canister system. Use CHART C-3.

FUEL SYSTEM

- **CHECK:** For restricted fuel filter or improper fuel pressure. Use CHART A-7.

ADDITIONAL CHECKS

- **CHECK:** For correct engine calibrator (see Service Bulletins).
- **CHECK:** Alternator output voltage. Repair, if less than 9 or more than 16.9 volts.

CUTS OUT, MISSES

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms," in this section.

IGNITION SYSTEM

- **CHECK:** For cylinder miss by:
  1. Start engine, allow engine to stabilize then disconnect idle air control motor. Remove one spark plug wire at a time, using insulated pliers.
  2. If there is a revolutions per minute drop, on all cylinders (equal to within 50 revolutions per minute), go to "Rough, Unstable Or Incorrect Idle, Stalling" symptom. Reconnect idle air control motor.
  3. If there is no revolutions per minute drop on one or more cylinders, or excessive variation in drop, check for spark, on the suspected cylinder(s) with J 26792 (ST-125) Spark Tester. If no spark, use CHART C-4. If there is spark, remove spark plug(s) in these cylinder(s) and check for:
     - Insulation Cracks
     - Wear
     - Improper Gap
     - Burned Electrodes
     - Heavy Deposits
- **CHECK:** For excessive spark plug wire resistance.

NOTICE: If the previous checks did not find the problem:

- Visually inspect ignition system for moisture, dust, cracks, burns, etc. With engine running spray plug wires with fine water mist to check for shorts.

FUEL SYSTEM

- **CHECK:** For contaminated fuel or restricted fuel filter or incorrect fuel pressure. Use CHART A-7.

ENGINE MECHANICAL

- **CHECK:** For proper valve timing. Remove rocker cover. Check for worn rocker arms, broken or weak valve springs, worn camshaft lobes. Repair as necessary. Refer to Engine Manual.
- **CHECK:** Low compression. Perform compression check. Refer to Engine Manual.
- **CHECK:** Intake and exhaust manifold passages for casting flash.

POOR FUEL ECONOMY

Definition: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms," in this section.
- Check air cleaner element (filter) for dirt or being plugged.
- Visually (physically) check: Vacuum hoses for splits, kinks, and proper connections.
- Perform "Diagnostic Circuit Check."
  - Is air conditioning "ON" full time?
  - Are tires at correct pressure?
  - Are excessively heavy loads being carried?
  - Is acceleration too much, too often?

NOTICE: Suggest owner fill fuel tank and recheck fuel economy.

IGNITION SYSTEM

- CHECK: Spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- CHECK: Ignition wires for cracking, hardness, and proper connections.

FUEL SYSTEM

- CHECK: Fuel pressure, use CHART A-7.

COOLING SYSTEM

- CHECK: Engine coolant level.
- CHECK: Engine thermostat for faulty part (always open) or for wrong heat range. Observe Tech 1 "Coolant Temp" with engine fully warm at road speed.

ADDITIONAL CHECKS

- CHECK: For correct engine calibrator installed in electronic control module. Observe Tech 1 "Calibration ID."
- CHECK: For proper calibration of speedometer.
- CHECK: For dragging brakes.

OCTANE ADJUSTMENT POTENTIOMETER

If premium octane fuel is being used, use Tech 1 to observe "Octane Adjust." With premium octane fuel the "Octane Adjust" value displayed on Tech 1 should be 0°. Use CHART C-15.

SENSORS

- CHECK: Coolant temperature sensor or air temperature sensor which may have shifted in value. Compare coolant temperature sensor resistance to the "Diagnostic Aids" chart on Code 14 or Code 15 chart.
- CHECK: Manifold absolute pressure sensor. Use CHART C-1D.

ROUGH, UNSTABLE OR INCORRECT IDLE, STALLING

(Page 1 of 2)

Definition: The engine runs unevenly at idle. If bad enough, the vehicle may shake. Also, the engine idle speed may vary (called "hunting"). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms," in this section.

SENSORS

- **CHECK:** Throttle position sensor - Use CHART C-1H.
- **CHECK:** Coolant temperature sensor - Using a Tech 1 "Scan" tool, compare coolant temperature with ambient temperature on a cold engine.
  - If coolant temperature reading 2°C greater than or less than ambient air temperature. Check for high resistance in coolant temperature sensor circuit or sensor itself. Compare resistance value to "Diagnostic Aids" on Code 14 and Code 15 chart.
- **CHECK:** Manifold absolute pressure sensor response and accuracy, manifold absolute pressure sensor vacuum hose, use CHART C-1D.

FUEL SYSTEM

- **CHECK:** Evaporative Emission Control System. Use CHART C-3.
- **CHECK:** Injector for leaking. Energize fuel system by either turning the ignition key to the "ON" position which will pressurize the fuel system for 2 seconds or by applying battery voltage to the fuel pump test terminal. (Assembly line data link terminal "G".) Applying battery voltage will force the fuel pump to run until the battery voltage is removed. Visually check injector and throttle body injection assembly for fuel leakage. Refer to CHART A-7 "Fuel System Diagnosis."
- **CHECK:** Fuel pressure, use CHART A-7.

IGNITION SYSTEM

- **CHECK:** Ignition system for:
  - Proper ignition voltage output with spark tester J 26792 (ST-125).
  - Spark plugs, wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits.
  - Spark plug leads/wires for excessive resistance.
  - Bare and shorted wires.
  - Crankshaft sensor resistance and connections.
  - Loose ignition coil connections.
- **CHECK:** For misfire at idle. Use CHART C-4B.

ROUGH, UNSTABLE OR INCORRECT IDLE, STALLING

(Page 2 of 2)

Definition: The engine runs unevenly at idle. If bad enough, the vehicle may shake. Also, the engine idle speed may vary (called "hunting"). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

ADDITIONAL CHECKS

- **CHECK:** Vacuum leaks can cause higher than normal idle speeds.
- **CHECK:** Idle air control operation, use CHART C-2C.
- **CHECK:** Electronic control module grounds for clean, tight, and in their proper location. These ground wires secure to the engine block on the direct ignition system bracket uppermost bolt. This bolt was previously used to retain the distributor on a carbureted engine.

NOTICE: Use Tech 1 "Scan" tool to determine if electronic control module is receiving air conditioning request signal. If problem exists only with air conditioning "ON," check air conditioning system for overcharge or undercharge of R12 refrigerant system.

- **CHECK:** Battery cables and ground straps should be clean and secure. Erratic voltage will cause idle air control to change its position, resulting in poor idle quality.
- **CHECK:** Idle air control valve will not move, if system voltage is below 9 or greater than 16.9 volts.
- **CHECK:** Crankcase ventilation system for proper operation (see: CHART C-13).

ENGINE MECHANICAL

- **CHECK:** For broken motor mounts.
- **CHECK:** Perform a compression check. Refer to Engine Manual.

EXCESSIVE EXHAUST EMISSIONS OR ODORS

Definition: Vehicle fails an emission test. Excessive odors do not necessarily indicate excessive emissions.

PRELIMINARY CHECKS

- Perform "Diagnostic Circuit Check."
- If EMISSION TEST shows excessive carbon monoxide and hydro carbons check items which cause vehicle to run RICH. Make sure engine is at normal operating temperature.
- If EMISSION TEST shows excessive oxides of nitrogen check items which cause car to run LEAN or too hot.

SENSORS

- **CHECK:** Manifold absolute pressure sensor - Use CHART C-1D to check the manifold absolute pressure sensor.

NOTICE: If the Tech 1 "Scan" tool indicates a very high coolant temperature and the system is running LEAN:

Check the cooling system and cooling fan for proper operation.

FUEL SYSTEM

- **CHECK:** For proper fuel cap.
- **CHECK:** Fuel pressure, use CHART A-7.

NOTICE: If test shows excessive oxides of nitrogen, check items which cause vehicle to run LEAN or too hot.

- **CHECK:** Canister for fuel loading. Refer to CHART C-3.

IGNITION SYSTEM

- **CHECK:** Ignition system for:
  - Proper ignition voltage output with spark tester J 26792 (ST-125).
  - Spark plugs, wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits.
  - Spark plug leads/wires for excessive resistance.
  - Bare and shorted wires.
  - Crankshaft sensor resistance and connections.
  - Loose ignition coil connections.

ADDITIONAL CHECKS

- **CHECK:** For vacuum leaks.
- **CHECK:** Carbon build-up in combustion chambers.
- **CHECK:** Crankcase ventilation system for proper operation (see: CHART C-13).

DIESELING, RUN-ON

Definition: Engine continues to run after key is turned "off," but runs very roughly. If engine runs smoothly, check ignition switch and adjustment, and short to voltage on ignition switch voltage input circuit.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms," in this section.

FUEL SYSTEM

- **CHECK:** Injector for leaking. Energize fuel system by either turning the ignition key to the "ON" position which will pressurize the fuel system for 2 seconds or by applying battery voltage to the fuel pump test terminal. (Assembly line data link terminal "G".) Applying battery voltage will force the fuel pump to run until the battery voltage is removed. Visually check injector and throttle body injection assembly for fuel leakage. Refer to CHART A-7 "Fuel System Diagnosis."

BACKFIRE

Definition: Fuel ignites in intake manifold, or in exhaust system, making a loud popping noise.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms," in this section.

IGNITION SYSTEM

- **CHECK:** Proper ignition coil output voltage with spark tester J 26792 (ST-125).
- **CHECK:** Spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits, repair or replace as necessary.
- **CHECK:** For defective insulation on the spark plug wires or boots. This would allow high voltage arching to engine parts, mostly noticeable during acceleration.
- **CHECK:** For excessive spark plug wire resistance.
- **CHECK:** For crossfire between spark plug wires (proper routing of plug wires). Refer to Engine Manual.

ENGINE MECHANICAL

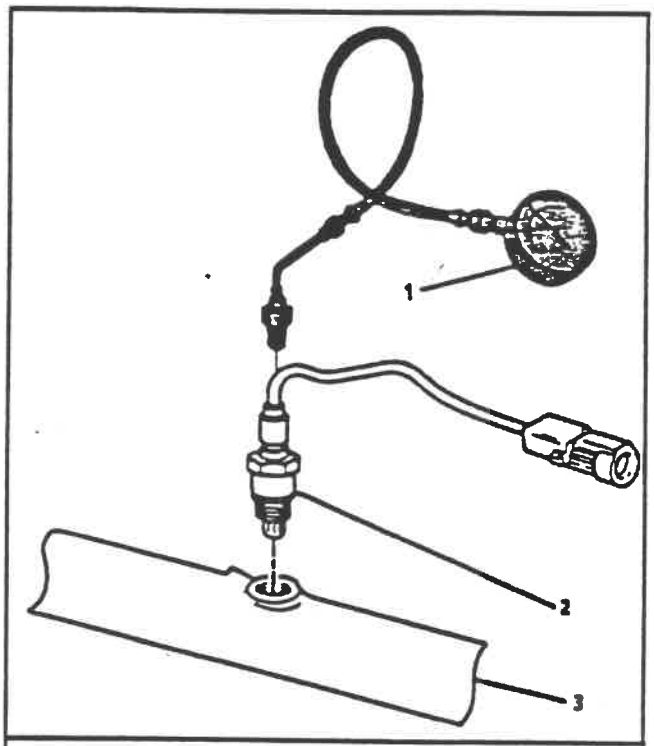
- **CHECK:** Perform a compression check. Refer to Engine Manual.
- **CHECK:** Valve timing. Remove rocker cover. Check for worn rocker arms, broken or weak valve springs, worn camshaft lobes or misadjusted valve clearances.
- **CHECK:** Intake manifold gasket for vacuum leaks.
- **CHECK:** Intake and exhaust manifolds for casting flash.

CHART B-1

RESTRICTED EXHAUST SYSTEM CHECK

CHECK AT OXYGEN SENSOR:

1. Carefully remove oxygen sensor.
2. Install exhaust backpressure tester (BT-8515-V) or equivalent in place of oxygen sensor (see illustration).
3. After completing test described below, be sure to coat threads of oxygen sensor with anti-seize compound or equivalent prior to re-installation.



1 BACK PRESSURE GAGE
2 OXYGEN SENSOR (O2S)
3 EXHAUST MANIFOLD

7S 3338-6E

DIAGNOSIS:

1. With the engine at normal operating temperature and running at 2500 revolutions per minute, observe the exhaust system backpressure reading on the gauge.
2. If the pressure exceeds 1 1/4 psi (8.62 kPa), a restricted exhaust system is indicated.
3. Inspect the entire exhaust system for a collapsed pipe, heat distress, or possible internal muffler failure.
4. If there are no obvious reasons for the excessive backpressure, a restricted catalytic converter should be suspected, and replaced using current recommended procedures.

4-26-93
NS 14489

ELECTRONIC CONTROL MODULE PIN CONNECTOR "A" SYMPTOMS CHART

24-PIN A-B CONNECTOR

This electronic control module symptoms chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

BACKPROBE CONNECTORS *ONLY*!

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (For "Engine Run" column)
- Diagnostic "test" terminal not grounded
- Tech 1 "Scan" tool not installed
- Air conditioning "OFF"
- Digital voltmeter "—" (negative) lead connected to a good clean ground point.

PIN FUNCTION	WIRE COLOR	COMPONENT/ CONNECTOR CAVITY	NORMAL VOLTAGE		CODES AFFECT.	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
			IGN "ON"	ENG. RUN		
A1 FUEL SYSTEM RELAY CONTROL	GREEN/ WHITE	FUEL PUMP RELAY "2"	(1) 0**	B+	NONE	NO START, SEE CHART A-7. PUMP RUNS ALL THE TIME (11).
A2 NO CONNECTION						
A3 PULSE WIDTH MODULATOR CANISTER CONTROL	GREEN/ YELLOW	CANISTER "B"	0*	0*	NONE	FUEL LOSS OR FUEL VAPOR ODOR, POOR IDLE, STALLING, POOR DRIVEABILITY.
A4 NO CONNECTION						
A5 "CHECK ENGINE" LIGHT CONTROL	BLACK/ WHITE	INSTRUMENT PANEL CLUSTER	0*	B+	NONE	NO CHECK ENGINE LIGHT (8), LIGHT "ON" ALL THE TIME, DOES NOT FLASH CODES (10). SEE "DIAGNOSTIC CIRCUIT CHECK."
A6 IGNITION SWITCH VOLTAGE INPUT SIGNAL	PINK/ BLACK	DIRECT IGNITION SYSTEM MODULE 2 CONNECTOR PIN "B" AND 6 CONNECTOR PIN "B"	B+	B+	53	NO START, NO CHECK ENGINE LIGHT, NO SERIAL DATA (8), FUSE BLOWN (10), SEE "DIAGNOSTIC CIRCUIT CHECK." ENGINE WILL NOT STOP RUNNING. (11).
A7 NO CONNECTION						
A8 SERIAL DATA COMMUNICATIONS	ORANGE	ASSEMBLY LINE DATA LINK "M"	2-5 VARYING	2-5 VARYING	NONE	NO ASSEMBLY LINE DATA LINK OR WILL NOT FLASH CODE 12 (9). SEE "DIAGNOSTIC CIRCUIT CHECK."
A9 DIAGNOSTIC "TEST" TERMINAL INPUT SIGNAL	BLACK/ WHITE	ASSEMBLY LINE DATA LINK "B"	5	5	NONE	NO ASSEMBLY LINE DATA LINK OR WILL NOT FLASH CODE 12 (8). FLASHES CODES, HIGH-SPEED FAN IS ON. (10). SEE "DIAGNOSTIC CIRCUIT CHECK."
A10 VEHICLE SPEED INPUT SIGNAL	GREEN	VEHICLE SPEED SENSOR "2"	VARIES	VARIES	24	ENGINE MAY STALL AT COASTDOWN, TECH 1 SCAN VEHICLE SPEED DOES NOT MATCH SPEEDOMETER (9,11).
A11 COOLANT TEMPERATURE AND THROTTLE POSITION SENSOR GROUND	PINK/ BLACK	COOLANT TEMPERATURE SENSOR "A" THROTTLE POSITION SENSOR "B"	0**	0**	15 21 (8)	HIGH IDLE, ROUGH IDLE, HARD TO START, POOR PERFORMANCE, EXCESSIVE EXHAUST EMISSIONS (8).
A12 ELECTRONIC CONTROL MODULE GROUND	BROWN	ASSEMBLY LINE DATA LINK "A"	0**	0**	NONE	"A12" AND "D1" OPEN - NO START (8). POOR GROUNDS - POOR PERFORMANCE. SEE "DIAGNOSTIC CIRCUIT CHECK."

1 Battery voltage for first two seconds after ignition is turned "ON" without cranking the engine.
2 When vehicle is stopped, voltage will be either less than 1 volt or greater than 10 volts; depending upon position of drive wheels. When vehicle is moving, voltage will vary depending upon vehicle speed.
3 Varies with temperature.
4 Varies. With ignition "ON" reads barometric pressure. With engine running, reads engine load.
5 Voltage will vary with engine revolutions per minute.
6 Depending on octane adjust potentiometer trim.
7 Battery voltage (B +) with engine warm.
8 Open.
9 Open/Grounded circuit.
10 Grounded circuit.
11 Short to +12 volts.
* Less than 0,50 volts.
** Less than 0,10 volts.
**** Air Conditioning Vehicles Only
B+ Should equal battery voltage.

9-17-92
NS 14374

ELECTRONIC CONTROL MODULE PIN CONNECTOR "B" SYMPTOMS CHART

24-PIN A-B CONNECTOR

This electronic control module symptoms chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

BACKPROBE CONNECTORS *ONLY*!

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (For "Engine Run" column)
- Diagnostic "test" terminal not grounded
- Tech 1 "Scan" tool not installed
- Air conditioning "OFF"
- Digital voltmeter "—" (negative) lead connected to a good clean ground point.

PIN FUNCTION	WIRE COLOR	COMPONENT/ CONNECTOR/ CAVITY	NORMAL VOLTAGE		CODES AFFECT.	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
			IGN. "ON"	ENG. RUNNING		
B1 BATTERY + (POWER SUPPLY)	RED	ELECTRONIC CONTROL MODULE "B1"	B+	B+	NONE	FUSIBLE LINK BLOWN, NO START (10), IF "C16" AND "B1" OPEN, NO START. SEE "DIAGNOSTIC CIRCUIT CHECK."
B2 NO CONNECTION						
B3 CRANKSHAFT REFERENCE LOW	BLACK/ RED	6-PIN CONNECTOR "F"	0**	0**	NONE	MAY HAVE POOR PERFORMANCE, FLICKERING CHECK ENGINE LIGHT (9), NO START, POSSIBLE IGNITION MODULE DAMAGE (11).
B4 NO CONNECTION						
B5 CRANKSHAFT REFERENCE INPUT SIGNAL	PURPLE/ WHITE	6-PIN CONNECTOR "E"	0*	1,0 (6)	NONE	NO START (9). SEE "DIAGNOSTIC CIRCUIT CHECK.".
B6 NO CONNECTION						
B7 NO CONNECTION						
B8 AIR CONDITIONING REQUEST INPUT SIGNAL	GREEN	HIGH-SIDE HIGH-PRESSURE SWITCH	"OFF" 0* "ON" 0*	0* B+	NONE	NO AIR CONDITIONING (9). SEE CHART C10. AIR CONDITIONING RUNS CONTINUOUSLY (11).
B9 NO CONNECTION						
B10 NO CONNECTION						
B11 NO CONNECTION						
B12 OCTANE ADJUST INPUT SIGNAL	GREEN	OCTANE ADJUST PIN "1"			54	SPARK KNOCK

1 Battery voltage for first two seconds, after ignition is turned "ON" without cranking the engine.

2 When vehicle is stopped, voltage will be either less than 1 volt or greater than 10 volts; depending upon position of drive wheels. When vehicle is moving, voltage will vary depending upon vehicle speed.

3 Varies with temperature.

4 Varies. With ignition "ON" reads barometric pressure. With engine running, reads engine load.

5 Voltage will vary with engine revolutions per minute.

6 Depending on octane adjust potentiometer trim.

7 Battery voltage (B +) with engine warm.

8 Open.

9 Open/Grounded circuit.

10 Grounded circuit.

11 Short to +12 volts.

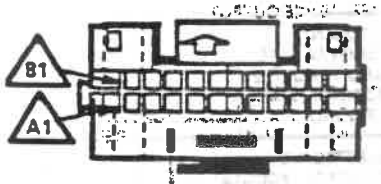
* Less than 0,50 volts.

** Less than 0,10 volts.

**** Air Conditioning Vehicles Only

B+ Should equal battery voltage.

24-PIN A-B CONNECTOR



BACK VIEW OF CONNECTOR

5-27-92
NS 14375

ELECTRONIC CONTROL MODULE PIN CONNECTOR "C" SYMPTOMS CHART

32-PIN C-D CONNECTOR

This electronic control module symptoms chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

BACKPROBE CONNECTORS *ONLY*!

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (For "Engine Run" column)
- Diagnostic "test" terminal not grounded
- Tech 1 "Scan" tool not installed
- Air conditioning "OFF"
- Digital voltmeter "—" (negative) lead connected to a good clean ground point.

	PIN FUNCTION	WIRE COLOR	COMPONENT/ CONNECTOR CAVITY	NORMAL VOLTAGE IGN "ON"	NORMAL VOLTAGE ENG. RUN	CODES AFFECT.	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
C1	NO CONNECTION						
C2	INTAKE MANIFOLD ELECTRIC HEATER RELAY CONTROL	PINK/ BLACK	INTAKE MANIFOLD HEATER RELAY CONNECTOR "4"	B+ (8)	B+	NONE	COLD DRIVEABILITY COMPLAINTS.
C3	IDLE AIR CONTROL COIL "B" LOW	GREEN/ BLACK	IDLE AIR CONTROL VALVE "A"	NOT	USEABLE	35	STALLING, ROUGH, UNSTABLE OR INCORRECT IDLE (9). SEE CHART C-2C.
C4	IDLE AIR CONTROL COIL "B" HIGH	GREEN/ WHITE	IDLE AIR CONTROL VALVE "B"	NOT	USEABLE	35	STALLING, ROUGH, UNSTABLE OR INCORRECT IDLE (9). SEE CHART C-2C.
C5	IDLE AIR CONTROL COIL "A" LOW	BLUE/ BLACK	IDLE AIR CONTROL VALVE "C"	NOT	USEABLE	35	STALLING, ROUGH, UNSTABLE OR INCORRECT IDLE (9). SEE CHART C-2C.
C6	IDLE AIR CONTROL COIL "A" HIGH	BLUE/ WHITE	IDLE AIR CONTROL VALVE "D"	NOT	USEABLE	35	STALLING, ROUGH, UNSTABLE OR INCORRECT IDLE (9). SEE CHART C-2C.
C7	NO CONNECTION						
C8	NO CONNECTION						
C9	NO CONNECTION						
C10	COOLANT TEMPERATURE INPUT SIGNAL	YELLOW	COOLANT TEMPERATURE SENSOR "B"	(4) 1 – 2	1 – 2	14, 15	HARD TO START, HIGH EXHAUST EMISSIONS (9).
C11	MANIFOLD ABSOLUTE PRESSURE INPUT SIGNAL	GREEN	MANIFOLD ABSOLUTE PRESSURE SENSOR "B"	3,5 – 5,0 (5)	0,9 – 1,5	33, 34	POOR PERFORMANCE, ROUGH IDLE, STALLING (9), SEE CHART C-1D
C12	INTAKE AIR TEMPERATURE INPUT SIGNAL	WHITE	INTAKE AIR TEMPERATURE SENSOR "B"	1,3	1,3	23, 25	POSSIBLE STRONG EXHAUST. TECH 1 READS -30°C (-36°F) (9). TECH 1 READS 179°C (354°F) (9).
C13	THROTTLE POSITION INPUT SIGNAL	BLUE	THROTTLE POSITION SENSOR "C"	0,3 – 0,7	0,3 – 0,7	21, 22	POOR PERFORMANCE, HIGH IDLE (9) SEE CHART C-1H. HARD TO START WHEN COLD (11).
C14	+5 VOLTS REFERENCE OUTPUT	GRAY	THROTTLE POSITION SENSOR "A", MANIFOLD ABSOLUTE PRESSURE SENSOR "C"	5	5	21, 22, 33, 34	SURGE, RUNS ROUGH, HIGH IDLE, HARD TO START, EXCESSIVE EXHAUST EMISSIONS OR ODORS, POOR PERFORMANCE, ROUGH IDLE (9).
C15	NO CONNECTION						
C16	(POWER SUPPLY) BATTERY +	RED	ELECTRONIC CONTROL MODULE "C-16"	B+	B+	NONE	FUSIBLE LINK BLOWN, NO START (10), IF "C16" AND "81" OPEN, NO START. SEE "DIAGNOSTIC CIRCUIT CHECK."

1 Battery voltage for first two seconds, after ignition is turned "ON" without cranking the engine.
2 When vehicle is stopped, voltage will be either less than 1 volt or greater than 10 volts; depending upon position of drive wheels. When vehicle is moving, voltage will vary depending upon vehicle speed.
3 Varies with temperature.
4 Varies. With ignition "ON" reads barometric pressure. With engine running, reads engine load.
5 Voltage will vary with engine revolutions per minute.
6 Depending on octane adjust potentiometer trim.
7 Battery voltage (B +) with engine warm.
8 Open.
9 Open/Grounded circuit.
10 Grounded circuit.
11 Short to +12 volts.
* Less than 0,50 volts.
** Less than 0,10 volts.
**** Air Conditioning Vehicles Only
B+ Should equal battery voltage.

5-27-92
NS 14376

ELECTRONIC CONTROL MODULE PIN CONNECTOR "D" SYMPTOMS CHART

32-PIN C-D CONNECTOR

This electronic control module symptoms chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

BACKPROBE CONNECTORS *ONLY*!

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (For "Engine Run" column)
- Diagnostic "test" terminal not grounded
- Tech 1 "Scan" tool not installed
- Air conditioning "OFF"
- Digital voltmeter "—" (negative) lead connected to a good clean ground point.

PIN FUNCTION	WIRE COLOR	COMPONENT/ CONNECTOR CAVITY	NORMAL VOLTAGE		CODES AFFECT.	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
			IGN "ON"	ENG. RUN		
D1 ELECTRONIC CONTROL MODULE GROUND	BROWN	ENGINE GROUND	0**	0**	NONE	"A-12" AND "D-1" OPEN, NO START. SEE "DIAGNOSTIC CIRCUIT CHECK," SEE TERMINAL "A12".
D2 OCTANE ADJUST POTENTIOMETER, MANIFOLD ABSOLUTE PRESSURE SENSOR AND INTAKE AIR TEMPERATURE SENSOR GROUND	BLACK	OCTANE ADJUST "3" MANIFOLD ABSOLUTE PRESSURE "A" MANIFOLD AIR TEMPERATURE "A"	0**	0**	54, 33, 23	ROUGH OR UNSTABLE IDLE, MAY STALL, POOR PERFORMANCE (8). SEE CHART C-10.
D3 NO CONNECTION						
D4 ELECTRONIC SPARK TIMNG OUTPUT	GREEN/ WHITE	6-PIN CONNECTOR "C"	(5) 0*	1,12	42	HARD TO START, STALLS, WILL RESTART IN BYPASS MODE. SEE CHART C-4 (9). STALLS, POOR IDLE, MAY SET CODE 42 (11).
D5 IGNITION MODULE BYPASS CONTROL	BLACK/ WHITE	6-PIN CONNECTOR "D"	0	4, 6	42	LACK OF POWER, POOR PERFORMANCE (9, 11) BY-PASS MODE, SEE CHART C-4.
D6 OXYGEN SENSOR GROUND	BROWN	ENGINE GROUND	0**	0*	13	OPEN LOOP, TECH 1 READS FIXED 400-500 mV (9).
D7 OXYGEN SENSOR INPUT SIGNAL	PINK	OXYGEN SENSOR	.45mV	.1 – .9mV	13	OPEN LOOP, STRONG EXHAUST ODOR (9).
D8 NO CONNECTION						
D9 INJECTOR CIRCUIT CURRENT LIMITED JUMPER	BLACK	ELECTRONIC CONTROL MODULE "D10"	0**	0**	NONE	NO START (8,11). MAY DAMAGE ELECTRONIC CONTROL MODULE OR INJECTOR (10).
D10 INJECTOR CIRCUIT CURRENT LIMITED JUMPER	BLACK	ELECTRONIC CONTROL MODULE "D9"	0**	0**	NONE	NO START (8,11). MAY DAMAGE ELECTRONIC CONTROL MODULE OR INJECTOR (10).
D11 NO CONNECTION						
D12 AIR CONDITIONING COMPRESSOR CLUTCH RELAY CONTROL	BLUE	AIR CONDITIONING RELAY #2	0*	0*	NONE	NO AIR CONDITIONING (8, 11). AIR CONDITIONING RUNS ALL THE TIME (10).
D13 NO CONNECTION						
D14 NO CONNECTION						
D15 NO CONNECTION						
D16 FUEL INJECTOR CONTROL	BLUE	ELECTRONIC CONTROL MODULE "D16"	B+	B+	NONE	IF "D16" IS OPEN, NO START. SEE CHART A-3. FLOOD ENGINE, FAIL ELECTRONIC CONTROL MODULE OR INJECTOR (10). NO START (11).

5 Voltage will vary with engine revolutions per minute.

6 Depending on octane adjust potentiometer trim.

7 Battery voltage (B +) with engine warm.

8 Open.

9 Open/Grounded circuit.

10 Grounded circuit.

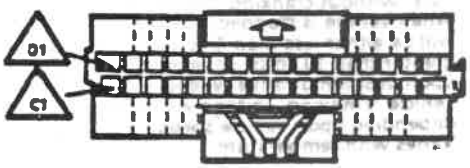
11 Short to +12 volts.

* Less than 0,50 volts.

** Less than 0,10 volts.

B+ Should equal battery voltage.

32-PIN C-D CONNECTOR



BACK VIEW OF CONNECTOR

6-2-92
NS 14377

SECTION 2.9C

COMPONENT SYSTEM CHARTS

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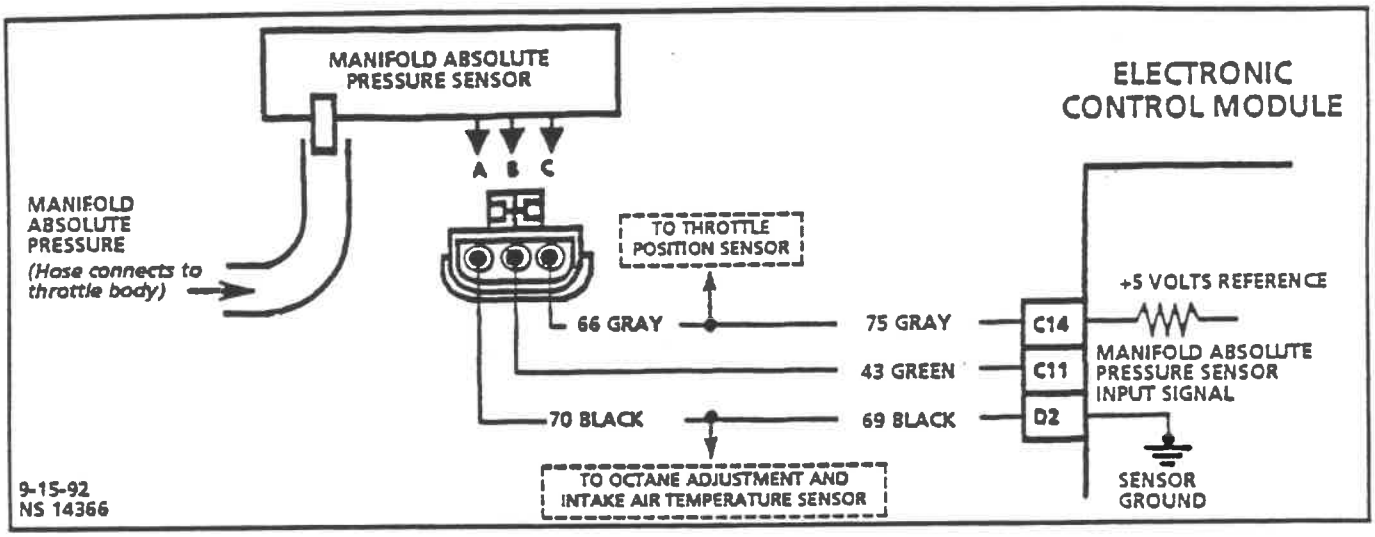

CHART C-1D

MANIFOLD ABSOLUTE PRESSURE OUTPUT CHECK 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The manifold absolute pressure sensor measures the changes in the intake manifold pressure which result from engine load (intake manifold vacuum) and revolutions per minute changes; and converts these into a voltage output. The electronic control module sends a 5 volt reference voltage to the manifold absolute pressure sensor. As the manifold pressure changes, the output voltage of the sensor also changes. By monitoring the sensor output voltage, the electronic control module knows the manifold pressure. A lower pressure (low voltage) output will be about 1-2 volts at idle. While higher pressure (high voltage) output will be about 4-4.8 at wide open throttle. The manifold absolute pressure sensor is also used, under certain conditions, to measure barometric pressure, allowing the electronic control module to make adjustments for different altitudes. The electronic control module uses the manifold absolute pressure sensor to control fuel delivery and ignition timing.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

Important

- Be sure to use the same diagnostic test equipment for all measurements.

1. Checks manifold absolute pressure sensor output voltage to the electronic control module. This voltage, without engine running, represents a barometer reading to the electronic control module. Comparison of this barometric reading on the same day with a known good vehicle is a good way to check accuracy of a "suspect" sensor. Readings should be the same ±0.2 volt.
2. Allowing 0.34 BAR (10" Hg) vacuum to the manifold absolute pressure sensor should cause the voltage to be at least 1.2 volts less than the voltage at Step 1. Upon applying vacuum to the sensor, the change in voltage should be instantaneous. A slow voltage change indicates a faulty sensor.
3. Check vacuum hose to sensor for leaking or restriction. Be sure no other vacuum devices are connected to the manifold absolute pressure sensor hose.

   NOTICE: The engine must be running in this step or the Tech 1 will not indicate a change in voltage. It is normal for the "Check Engine" light to come "ON" and for the system to set a Code 33 during this step. Make sure the code is cleared when this test is completed.
4. Disconnect sensor from bracket and twist sensor (BY HAND ONLY) to check for intermittent connection. Output changes greater than 0.1 volt indicate a faulty connector or connection. If OK, replace sensor.

CHART C-1D
MANIFOLD ABSOLUTE PRESSURE OUTPUT CHECK 1.7L THROTTLE BODY INJECTION NIVA

NOTE: THIS CHART APPLIES ONLY TO MAP SENSORS HAVING GREEN OR BLACK COLOR KEY INSERT (SEE BELOW).

1
- IGNITION "ON," ENGINE NOT RUNNING.
- CONNECT TECH 1 "SCAN" TOOL.
- SELECT "F0: DATA LIST."
- TECH 1 SHOULD INDICATE A MANIFOLD ABSOLUTE PRESSURE SENSOR VOLTAGE.
- COMPARE THIS READING WITH THE READING OF A KNOWN GOOD VEHICLE. SEE FACING PAGE TEST DESCRIPTION, STEP 1.
- VOLTAGE READING SHOULD BE WITHIN ±0.2 VOLT.

IS IT?

YES → **2**

NO → REPLACE MANIFOLD ABSOLUTE PRESSURE SENSOR.

2
- DISCONNECT AND PLUG VACUUM SOURCE TO MANIFOLD ABSOLUTE PRESSURE SENSOR.
- CONNECT A HAND VACUUM PUMP TO MANIFOLD ABSOLUTE PRESSURE SENSOR.
- START ENGINE.
- NOTE MANIFOLD ABSOLUTE PRESSURE SENSOR VOLTAGE.
- APPLY 0.34 BAR (10" Hg) OF VACUUM AND NOTE VOLTAGE CHANGE. SUBTRACT SECOND READING FROM THE FIRST. VOLTAGE DIFFERENCE VALUE SHOULD BE GREATER THAN 1.5 VOLTS.

IS IT?

YES → **3**

NO → **4**

3 NO TROUBLE FOUND. CHECK SENSOR VACUUM SOURCE FOR LEAKAGE OR RESTRICTION. BE SURE THIS SOURCE SUPPLIES VACUUM TO MANIFOLD ABSOLUTE PRESSURE SENSOR ONLY.

4 CHECK SENSOR CONNECTION. IF OK, REPLACE MANIFOLD ABSOLUTE PRESSURE SENSOR.

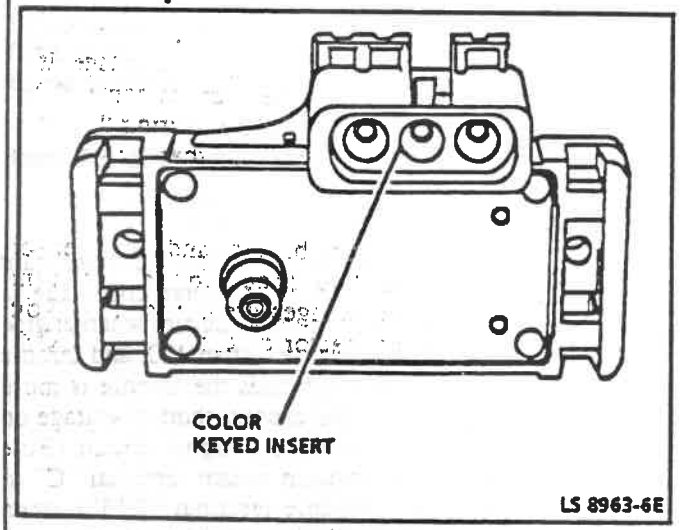

Figure 1 - Typical Key Insert

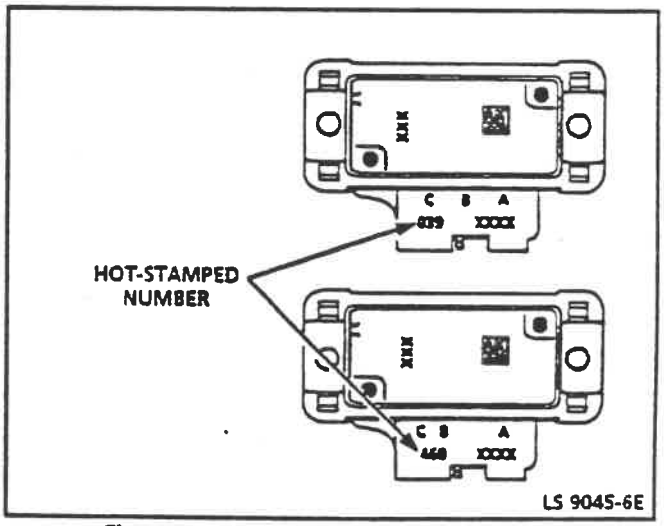

Figure 2 - Typical Hot-Stamped Number

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

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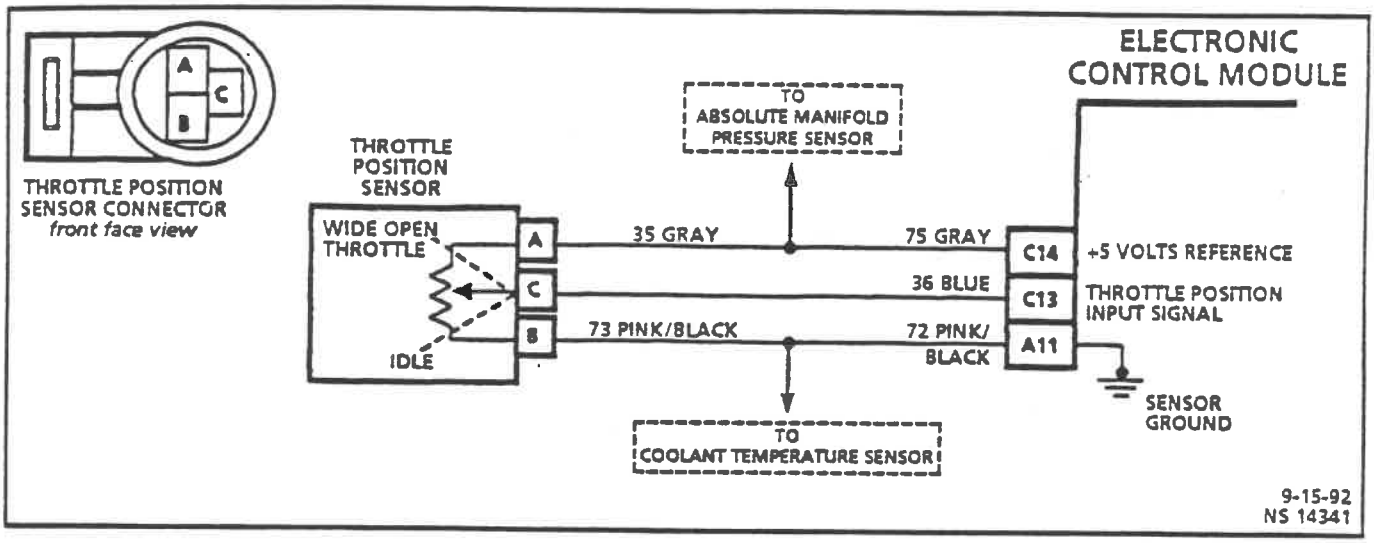


CHART C-1H

THROTTLE POSITION SENSOR OUTPUT CHECK 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The throttle position sensor is attached to the throttle body, and is internally rotated by the throttle body shaft. It is a potentiometer with one end connected to 5 volts from the electronic control module and the other to electronic control module ground. A third wire is connected to the electronic control module, allowing it to measure the variable output voltage from the throttle position sensor.

As the throttle valve angle is changed (accelerator pedal moved), the throttle position sensor output voltage also changes in proportion. At a closed throttle position, the output voltage is usually below 1.0 volt. As the throttle valve opens, the output increases so that, at wide open throttle, the output should be above 4.0 volts. By monitoring the output voltage from the throttle position sensor, the electronic control module can determine fuel needs based on throttle opening (driver demand).

A broken or loose throttle position sensor, or one that has an unstable output, can cause intermittent bursts of fuel because the electronic control module thinks the throttle is moving. Results could include engine surge or poor idle quality. If the electronic control module interprets a high voltage when engine revolutions per minute is less than 420, hard starting could be the result ("clear-flood" mode). A problem in any of the throttle position sensor circuits will set either a Code 21 or 22 after the engine is started. Once a code is set, the electronic control module will use an artificial default value for throttle position sensor based on engine revolutions per minute to enable the vehicle to be driven, although performance could be less than normal.

The throttle position sensor is not adjustable. The electronic control module uses the reading at idle as "0% throttle," so no adjustment is necessary.

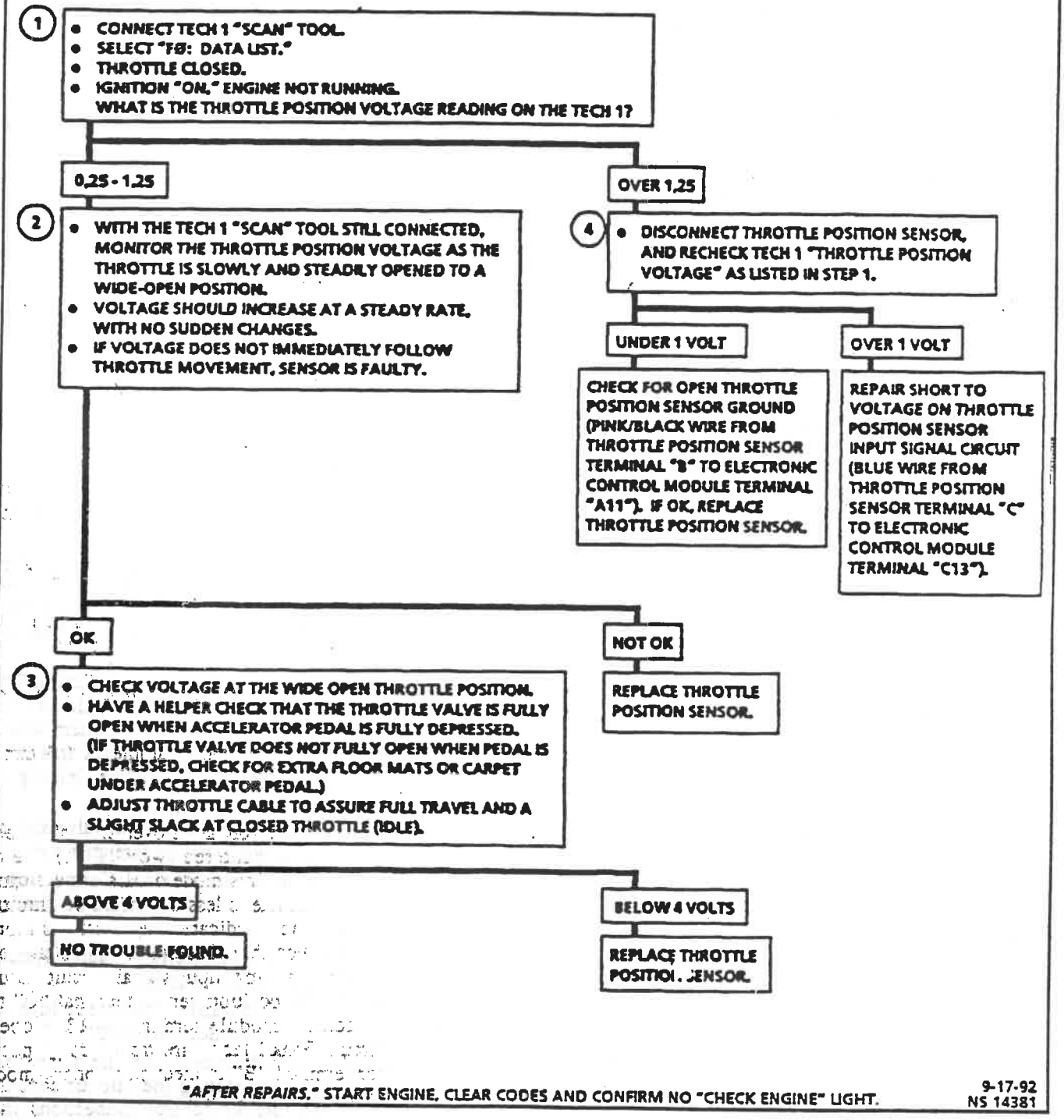
Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. This is a check of the voltage at the idle position. It is usually less than 1.0 volt.
2. The voltage should increase at the same steady rate at which the throttle is opened with the throttle valve.
3. With the throttle valve wide open, the throttle position sensor output needs to be above 4 volts, allowing the electronic control module to interpret a wide open throttle position.
4. If the closed-throttle voltage is over 2.5 volts, hard starting may be encountered (worse cold) due to "clear-flood" mode. This mode occurs when engine revolutions per minute is less than 420, and throttle position sensor input indicates the throttle is more than 80% open. Possible causes: short to voltage on throttle position sensor input signal circuit (Blue wire from throttle position sensor terminal "C" to electronic control module terminal "C13"), open ground circuit (Pink/Black wire from throttle position sensor terminal "B" to electronic control module terminal "A11"), or a faulty sensor.

CHART C-1H

THROTTLE POSITION SENSOR OUTPUT CHECK 1.7L THROTTLE BODY INJECTION NIVA

IF A CODE 21 OR 22 IS PRESENT, FOLLOW THAT CHART FIRST.


1
• CONNECT TECH 1 "SCAN" TOOL.
• SELECT "F0: DATA LIST."
• THROTTLE CLOSED.
• IGNITION "ON," ENGINE NOT RUNNING.
WHAT IS THE THROTTLE POSITION VOLTAGE READING ON THE TECH 1?
0,25 - 1,25
OVER 1,25
2
• WITH THE TECH 1 "SCAN" TOOL STILL CONNECTED, MONITOR THE THROTTLE POSITION VOLTAGE AS THE THROTTLE IS SLOWLY AND STEADILY OPENED TO A WIDE-OPEN POSITION.
• VOLTAGE SHOULD INCREASE AT A STEADY RATE, WITH NO SUDDEN CHANGES.
• IF VOLTAGE DOES NOT IMMEDIATELY FOLLOW THROTTLE MOVEMENT, SENSOR IS FAULTY.
4
• DISCONNECT THROTTLE POSITION SENSOR, AND RECHECK TECH 1 "THROTTLE POSITION VOLTAGE" AS LISTED IN STEP 1.
UNDER 1 VOLT
OVER 1 VOLT
CHECK FOR OPEN THROTTLE POSITION SENSOR GROUND (PINK/BLACK WIRE FROM THROTTLE POSITION SENSOR TERMINAL "B" TO ELECTRONIC CONTROL MODULE TERMINAL "A11"). IF OK, REPLACE THROTTLE POSITION SENSOR.
REPAIR SHORT TO VOLTAGE ON THROTTLE POSITION SENSOR INPUT SIGNAL CIRCUIT (BLUE WIRE FROM THROTTLE POSITION SENSOR TERMINAL "C" TO ELECTRONIC CONTROL MODULE TERMINAL "C13").
OK
NOT OK
REPLACE THROTTLE POSITION SENSOR.
3
• CHECK VOLTAGE AT THE WIDE OPEN THROTTLE POSITION.
• HAVE A HELPER CHECK THAT THE THROTTLE VALVE IS FULLY OPEN WHEN ACCELERATOR PEDAL IS FULLY DEPRESSED. (IF THROTTLE VALVE DOES NOT FULLY OPEN WHEN PEDAL IS DEPRESSED, CHECK FOR EXTRA FLOOR MATS OR CARPET UNDER ACCELERATOR PEDAL.)
• ADJUST THROTTLE CABLE TO ASSURE FULL TRAVEL AND A SLIGHT SLACK AT CLOSED THROTTLE (IDLE).
ABOVE 4 VOLTS
BELOW 4 VOLTS
NO TROUBLE FOUND.
REPLACE THROTTLE POSITION SENSOR.
"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.
9-17-92
NS 14381

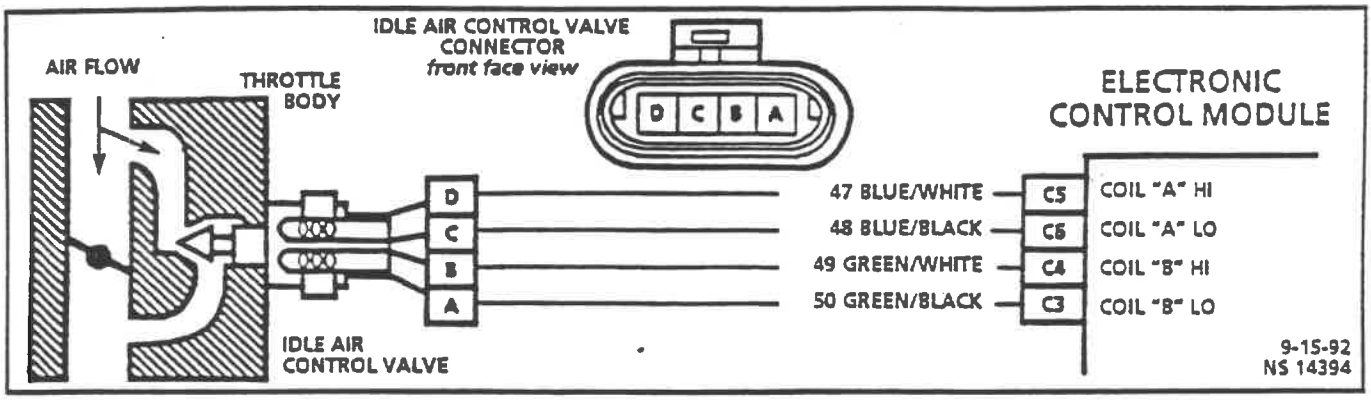


CHART C-2C

IDLE AIR CONTROL CIRCUIT CHECK 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The electronic control module controls idle revolutions per minute with the idle air control valve. To increase idle revolutions per minute, the electronic control module moves the idle air control valve out allowing more air to pass around the throttle plate. To decrease revolutions per minute, it moves the idle air control valve in, reducing air flow around the throttle plate. A Tech 1 "Scan" tool will read the electronic control module commands to the idle air control valve in counts.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. The Tech 1 revolutions per minute control mode is used to extend and retract the idle air control valve. The valve should move smoothly within the specified range. If the idle speed is commanded (idle air control extended) too low (below 750 revolutions per minute), the engine may stall. This may be normal and would not indicate a problem. Retracting the idle air control beyond its controlled range (above 1800 revolutions per minute) will cause a delay before the revolutions per minute start dropping. This too is normal.
2. This test uses the Tech 1 to command the idle air control controlled idle speed. The electronic control module issues commands to obtain commanded idle speed. The node lights each should flash red and green to indicate a good circuit as the electronic control module issues commands. While the sequence of color is not important if either light is "OFF" or does not flash red and green, check the circuits for faults, beginning with poor terminal contacts. Engine speed will not actually change, since the idle air control is disconnected.

Diagnostic Aids:

A slow, unstable, or fast idle may be caused by a non-idle air control system problem that cannot be overcome by the idle air control valve. Out of control range idle air control Tech 1 tool "idle air control" counts will be above 60 if idle is too low and zero counts if idle is too high. The following checks should be made to repair a non-idle air control system problem:

- **Vacuum Leak (High Idle).** If idle is too high, stop the engine. Fully extend (seat) idle air control using 222 DM idle air control "Motor Tester" in the A "Low Switch Position." Start engine. If idle speed is above 1000 revolutions per minute, locate and correct vacuum leak including Crankcase Ventilation System. Also check for binding of throttle blade or linkage.
- **Fuel System too lean (High Air/Fuel Ratio).** The idle speed may be too high or too low. Engine speed may vary up and down, and disconnecting the idle air control valve does not help. Check for low regulated fuel pressure, water in the fuel or a restricted injector.
- **Fuel System too rich (Low Air/Fuel Ratio).** The idle speed will be too low. "Scan" tool idle air control counts will usually be above 80. System would be obviously rich and may exhibit black smoke in exhaust. Check for high fuel pressure, leaking or sticking injector.
- **Throttle Body.** Remove idle air control valve and inspect bore and idle air passages for foreign material.
- **Idle Air Control Valve Electrical Connections.** Idle air control valve connections should be carefully checked for proper contact.
- **Crankcase Ventilation System.** A faulty system may result in an incorrect idle speed.
- Refer to "Rough, Unstable, Incorrect Idle or Stalling," in "Symptoms," Section "2.9B".
- If intermittent poor driveability or idle symptoms are resolved by disconnecting the idle air control, carefully recheck idle air control connections and terminal resistance.

CHART C-2C

IDLE AIR CONTROL CIRCUIT CHECK 1.7L THROTTLE BODY INJECTION NIVA

1

- ENGINE AT NORMAL OPERATING TEMPERATURE (85°C-95°C).
- ENGINE IDLING IN NEUTRAL WITH PARKING BRAKE SET.
- AIR CONDITIONING "OFF."
- CONNECT TECH 1 "SCAN" TOOL.
- SELECT "MISC. TESTS," THEN "IDLE SYSTEM," THEN "IDLE CONTROL."
- WITH THE THROTTLE REMAINING CLOSED, COMMAND THE DESIRED IDLE SPEED THROUGH RANGE FROM 700 REVOLUTIONS PER MINUTE UP TO 1500 REVOLUTIONS PER MINUTE.
- ENGINE SPEED SHOULD FOLLOW THE COMMANDED IDLE SPEED. DOES IT?

NO

2

- DISCONNECT HARNESS CONNECTOR FROM THE IDLE AIR CONTROL VALVE AND INSTALL HARNESS CONNECTOR INTO "NODE LIGHT" FROM TESTER KIT 222 DM.
- ENGINE RUNNING. USING TECH-1, COMMAND THE DESIRED IDLE SPEED THROUGH A RANGE UP AND DOWN.
- EACH NODE LIGHT SHOULD FLASH RED AND GREEN BUT NEVER "OFF." DO THEY?

NO

- FAULTY IDLE AIR CONTROL VALVE CONNECTOR TERMINAL CONTACTS.
- OPEN IDLE AIR CONTROL CIRCUITS INCLUDING CONNECTORS.
- IDLE AIR CONTROL CIRCUITS SHORTED TO GROUND OR VOLTAGE.
- FAULTY ELECTRONIC CONTROL MODULE CONNECTIONS OR REPLACE ELECTRONIC CONTROL MODULE. REPAIR AS NECESSARY AND RETEST.

YES

- CONNECT TOOL J 39763/CTI 222 DM "MOTOR TESTER" CLIP LEADS TO VEHICLE BATTERY THEN CONNECT ITS CONNECTOR TO THE IDLE AIR CONTROL VALVE.
- WITH ENGINE IDLING, CYCLE 222 DM SWITCH "HIGH" AND "LOW." ENGINE SPEED SHOULD INCREASE AND DECREASE AS TOOL SWITCH IS MOVED. DOES IT?

NO

CHECK IDLE AIR PASSAGES IN THROTTLE BODY UNIT. IF OK, REPLACE IDLE AIR CONTROL VALVE.

YES

REPLACE ELECTRONIC CONTROL MODULE

YES

- IGNITION "OFF."
- DISCONNECT THE HARNESS CONNECTOR FROM THE IDLE AIR CONTROL VALVE.
- USING THE DIGITAL VOLT OHM AMP MULTIMETER KIT J 39689, CHECK RESISTANCE ACROSS IDLE AIR CONTROL VALVE COILS.
- SHOULD BE 40 TO 80 OHMS BETWEEN IDLE AIR CONTROL VALVE TERMINALS "A" TO "B" AND "C" TO "D".

OK

- CHECK RESISTANCE BETWEEN IDLE AIR CONTROL VALVE TERMINALS "B" AND "C" AND "A" AND "D".
- SHOULD BE INFINITE, NO CONTINUITY OPEN CIRCUIT.

OK

IDLE AIR CONTROL VALE AND CIRCUITS ARE OK. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NOT OK

REPLACE IDLE AIR CONTROL VALVE AND RETEST.

NOT OK

REPLACE IDLE AIR CONTROL VALVE AND RETEST.

AFTER ALL IDLE AIR CONTROL TESTING IS COMPLETE, RESET THE IDLE AIR CONTROL VALVE. CONNECT TECH 1 "SCAN" TOOL. SELECT "MISC TEST," THEN "IDLE SYSTEM," THEN "IDLE RESET."

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

3-9-93
NS 14395

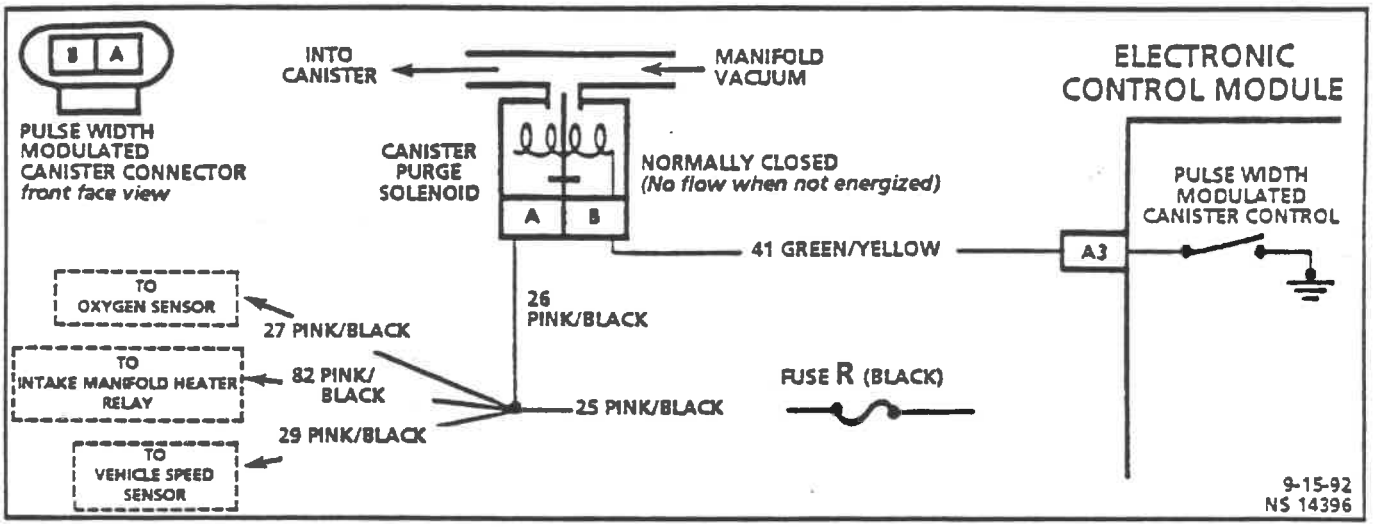


CHART C-3

CANISTER PURGE VALVE CHECK
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

Canister purge is controlled by a solenoid that allows manifold vacuum to purge the canister when energized. The electronic control module supplies a ground to energize the solenoid (purge "ON"). The purge solenoid controlled by the electronic control module is pulse width modulated (turned "ON" and "OFF" several times a second). The duty cycle (pulse width) is calculated based on the current value of the "Closed Loop" fuel adjustment.

The duty cycle is calculated by the electronic control module and the output commanded when the following conditions have been met:

- Battery voltage is less than 16.9 volts.
- Coolant temperature above 80°C.
- Vehicle speed above 21 kilometers per hour.
- Throttle position has exceeded 2%.

Also, if the diagnostic "test" terminal is grounded, with the engine stopped, the purge solenoid is energized (purge "ON").

NOTICE: Once enabled it will remain enabled except during a wide open throttle condition.

Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart.

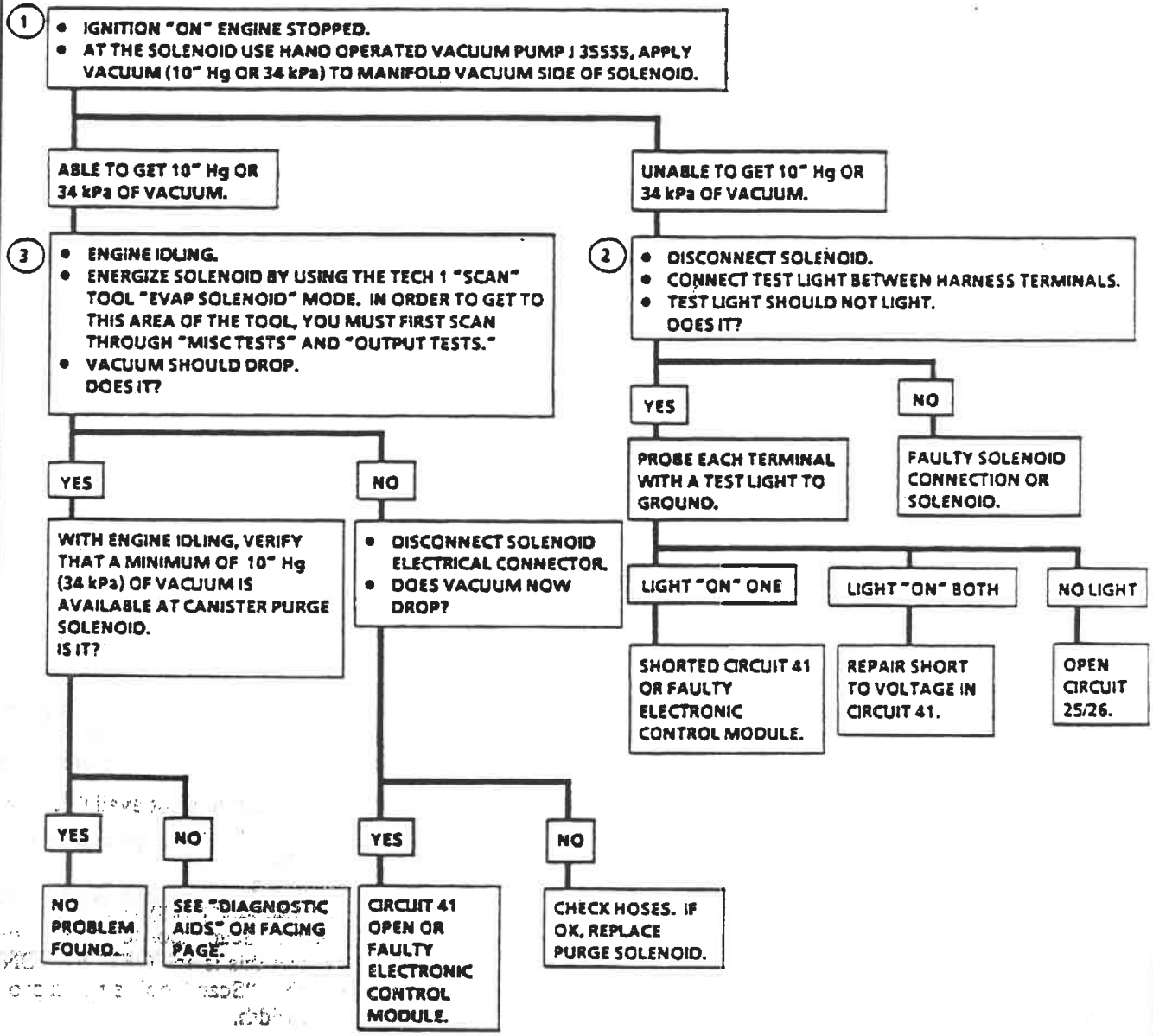
1. Checks to see if the solenoid is opened or closed. The solenoid is normally de-energized in this step; so it should be closed.
2. Checks for a complete circuit. Normally, there is ignition voltage on Circuit 25 and the electronic control module provides a ground on Circuit 41.
3. Completes functional check by grounding "test" terminal. This should normally de-energize the solenoid opening the valve which should allow the vacuum to drop (purge "ON").

Diagnostic Aids:

- If 10" Hg (34 kPa) of vacuum is not available at the solenoid check for:
  - Split or cracked hoses.
  - Pinched or plugged hoses.
  - Ensure hoses are installed correctly.
- When using the Tech 1 "Scan" tool to energize the solenoid, remember that this is an "OFF" and "ON" control only. The Tech 1 "Scan" tool is not capable of adjusting the pulse width.

CHART C-3

CANISTER PURGE VALVE CHECK 1.7L THROTTLE BODY INJECTION NIVA


1
• IGNITION "ON" ENGINE STOPPED.
• AT THE SOLENOID USE HAND OPERATED VACUUM PUMP J 35555, APPLY VACUUM (10" Hg OR 34 kPa) TO MANIFOLD VACUUM SIDE OF SOLENOID.
ABLE TO GET 10" Hg OR 34 kPa OF VACUUM.
UNABLE TO GET 10" Hg OR 34 kPa OF VACUUM.
3
• ENGINE IDLING.
• ENERGIZE SOLENOID BY USING THE TECH 1 "SCAN" TOOL "EVAP SOLENOID" MODE. IN ORDER TO GET TO THIS AREA OF THE TOOL, YOU MUST FIRST SCAN THROUGH "MISC TESTS" AND "OUTPUT TESTS."
• VACUUM SHOULD DROP.
DOES IT?
2
• DISCONNECT SOLENOID.
• CONNECT TEST LIGHT BETWEEN HARNESS TERMINALS.
• TEST LIGHT SHOULD NOT LIGHT.
DOES IT?
YES
NO
YES
NO
PROBE EACH TERMINAL WITH A TEST LIGHT TO GROUND.
FAULTY SOLENOID CONNECTION OR SOLENOID.
WITH ENGINE IDLING, VERIFY THAT A MINIMUM OF 10" Hg (34 kPa) OF VACUUM IS AVAILABLE AT CANISTER PURGE SOLENOID.
IS IT?
• DISCONNECT SOLENOID ELECTRICAL CONNECTOR.
• DOES VACUUM NOW DROP?
LIGHT "ON" ONE
LIGHT "ON" BOTH
NO LIGHT
SHORTED CIRCUIT 41 OR FAULTY ELECTRONIC CONTROL MODULE.
REPAIR SHORT TO VOLTAGE IN CIRCUIT 41.
OPEN CIRCUIT 25/26.
YES
NO
YES
NO
NO PROBLEM FOUND.
SEE "DIAGNOSTIC AIDS" ON FACING PAGE.
CIRCUIT 41 OPEN OR FAULTY ELECTRONIC CONTROL MODULE.
CHECK HOSES. IF OK, REPLACE PURGE SOLENOID.

11-2-92
NS 14397

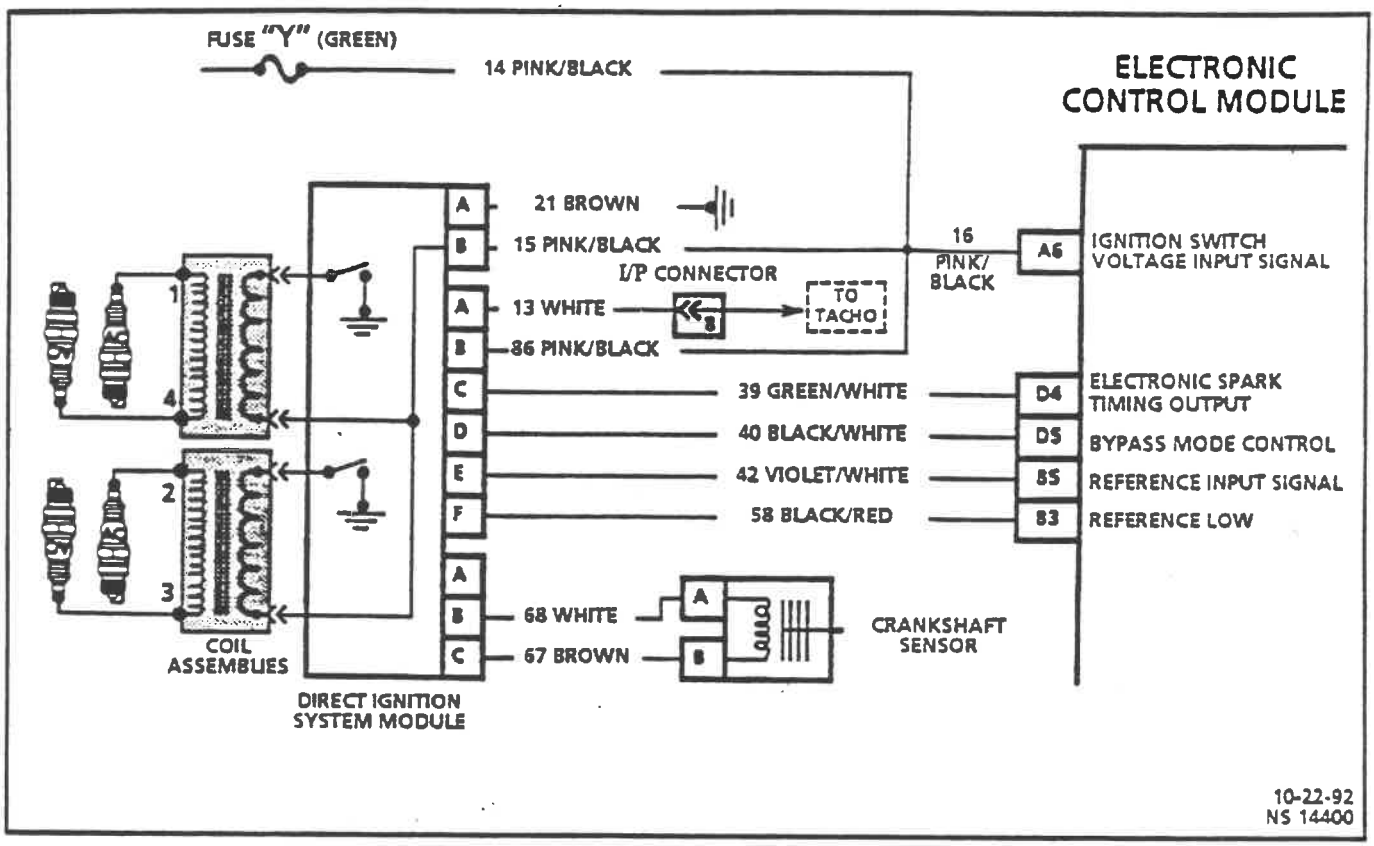


CHART C-4

(Page 1 of 2)
IGNITION SYSTEM CHECK
(NO SPARK)
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The direct ignition system uses a waste spark method of distribution. In this type of system, the ignition module triggers the correct ignition coil, based on signals from the crankshaft sensor. Each ignition coil provides the high secondary voltage required to fire two spark plugs at the same time on "companion" cylinders, i.e., cylinders with pistons at the top of their stroke top dead center at the same time. One of these pistons would be at the top of its compression stroke, the other piston would be at the top of its exhaust stroke.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Becasue the direct ignition system uses two plugs and wires to complete the circuit of each coil, the opposite spark plug cable should be connected to ground.
2. This test will determine if + battery voltage is available at the ignition module.
3. This test will determine if a good ground is available at the ignition module.
4. Checks for continuity of the crankshaft position sensor and connections.
5. Voltage will vary in this test depending on cranking speed of engine.

NOTE: THIS CHART ASSUMES THAT THE TECHNICIAN HAS PERFORMED DIAGNOSTIC CIRCUIT CHECK CHART A.

CHART C-4

(Page 1 of 2)
IGNITION SYSTEM CHECK
(NO SPARK)
1.7L THROTTLE BODY INJECTION NIVA

1
- USING SECONDARY IGNITION VOLTAGE IGNITION TESTER J 26792 ST-125 CHECK FOR SPARK.
- CHECK ONE CABLE AT A TIME.
- USING CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 TO JUMPER THE IGNITION COIL COMPANION CABLE CONNECTED TO GROUND WHILE CRANKING.
- CHECK FOR SPARK ON CABLES 1, 2, 3 AND 4.

IS THERE SPARK ON AT LEAST ONE CABLE?

NO

2
- IGNITION "OFF."
- DISCONNECT DIRECT IGNITION SYSTEM MODULE 2 PIN AND 6 PIN CONNECTOR.
- IGNITION "ON."
- CONNECT TEST LIGHT J 34142-B BETWEEN GROUND AND DIRECT IGNITION SYSTEM MODULE 2 PIN CONNECTOR HARNESS TERMINAL "B" AND CONNECT TEST LIGHT TO 6 PIN CONNECTOR HARNESS TERMINAL "B".

IS TEST LIGHT "ON" FOR EACH CIRCUIT?

YES

3
- CONNECT TEST LIGHT TO + BATTERY VOLTAGE AND DIRECT IGNITION SYSTEM MODULE 2 PIN CONNECTOR HARNESS TERMINAL "A".

IS TEST LIGHT "ON"?

YES

4
- DISCONNECT 3-WAY CONNECTOR FROM DIRECT IGNITION SYSTEM MODULE.
- WITH OHMMETER PROBE HARNESS TERMINALS "B AND C" OF 3-WAY HARNESS CONNECTOR, SHOULD READ BETWEEN 500-700 OHMS.

OK

5
- SET DIGITAL VOLTMETER J 39689 ON AC VOLTAGE POSITION. LEAVE METER LEADS CONNECTED TO 3-WAY HARNESS CONNECTOR, AS IN STEP 4.
- CRANK ENGINE AND OBSERVE VOLTAGE READING. READING SHOULD BE GREATER THAN 0.3 VOLT (300 mV).

IS IT?

YES

FAULTY CONNECTION OR FAULTY DIRECT IGNITION SYSTEM MODULE.

NO

FAULTY CONNECTION OR FAULTY CRANKSHAFT POSITION SENSOR.

NOT OK

LESS THAN 500 OHMS

SENSOR LEADS SHORTED TOGETHER OR FAULTY CRANKSHAFT POSITION SENSOR.

GREATER THAN 700 OHMS

OPEN SENSOR CIRCUIT 67 BROWN WIRE OR CIRCUIT 68 WHITE WIRE OR FAULTY CONNECTION OR FAULTY CRANKSHAFT POSITION SENSOR.

NO

FAULTY CONNECTION OR OPEN CIRCUIT 21 BROWN WIRE.

NO

FAULTY CONNECTION OR OPEN CIRCUIT 15/86 PINK/BLACK WIRE.

YES

SEE CHART C-4 PAGE 2 OF 2

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

2-8-93
NS 14979

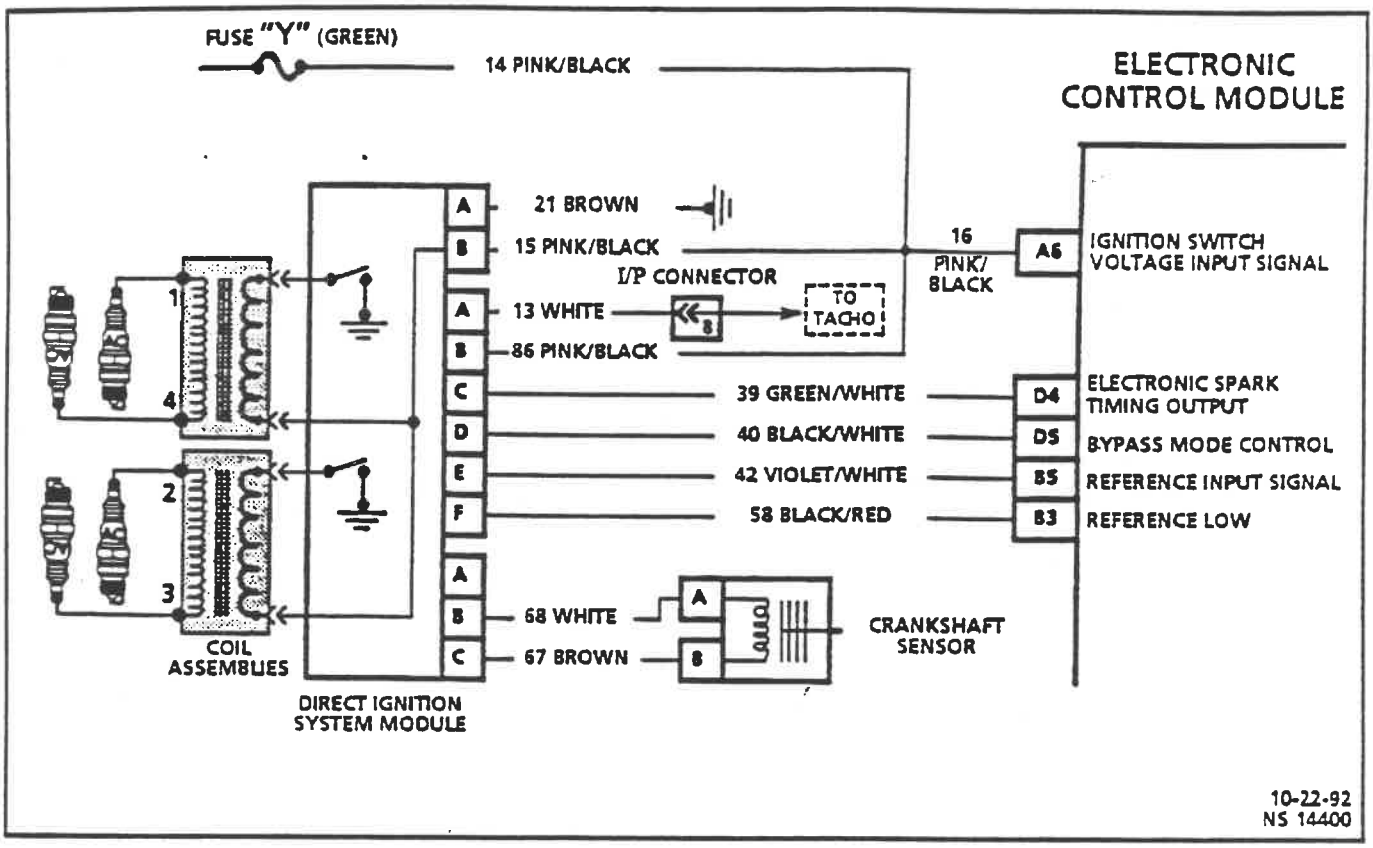


CHART C-4

(Page 2 of 2)
IGNITION SYSTEM CHECK
(NO SPARK)
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

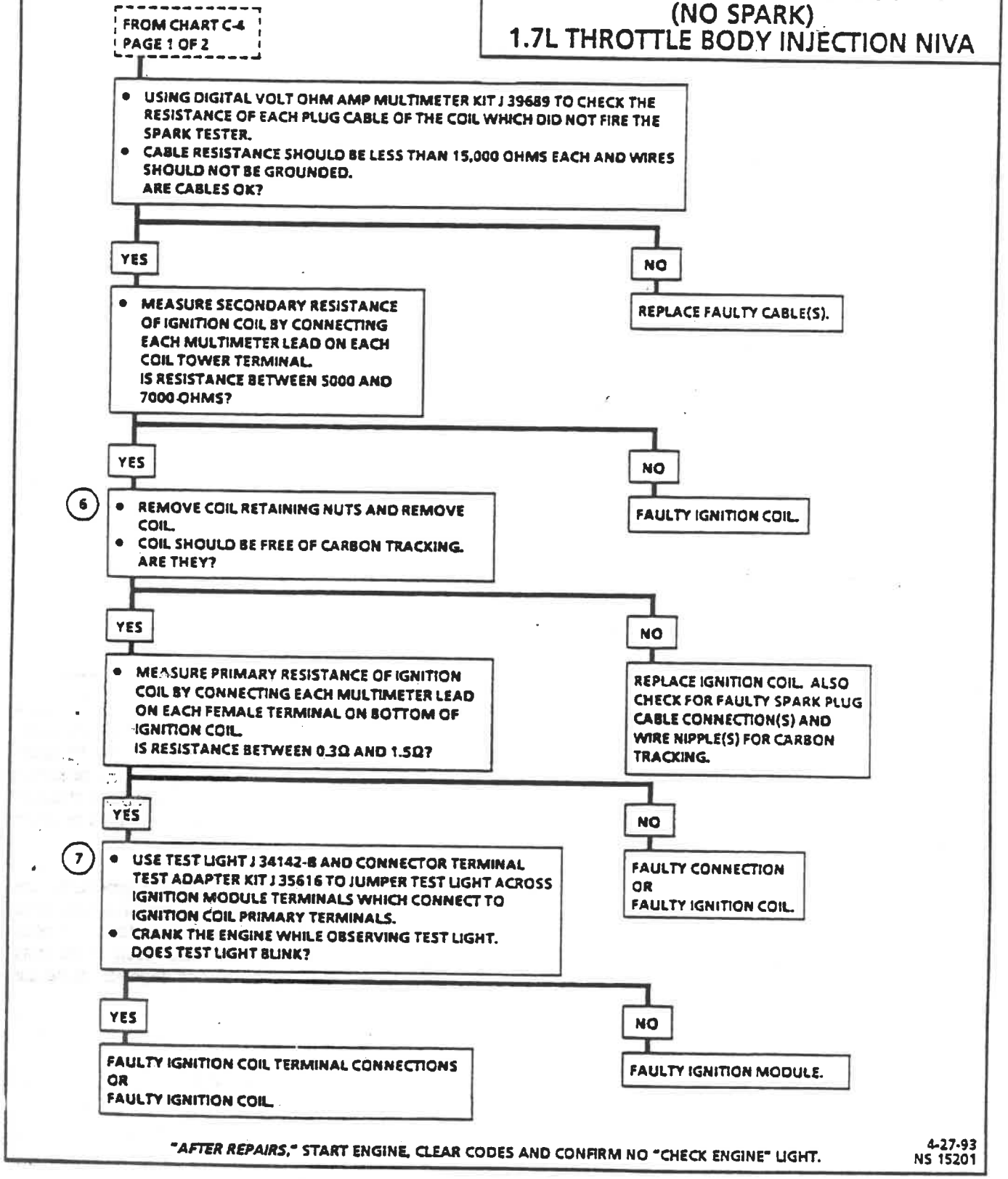
The direct ignition system uses a waste spark method of distribution. In this type of system, the ignition module triggers the correct ignition coil, based on signals from the crankshaft sensor. Each ignition coil provides the high secondary voltage required to fire two spark plugs at the same time on "companion" cylinders, i.e., cylinders with pistons at the top of their stroke top dead center at the same time. One of these pistons would be at the top of its compression stroke, the other piston would be at the top of its exhaust stroke.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

6. If carbon tracking is evident, replace coil and be sure plug wires relating to that coil are clean and tight. Excessive wire resistance or faulty connections could have caused the coil to be damaged.
7. This test will determine if the ignition module is not triggering the problem coil or if the tested coil is at fault. This test could also be performed by using another known good coil.

CHART C-4

(Page 2 of 2)
IGNITION SYSTEM CHECK
(NO SPARK)
1.7L THROTTLE BODY INJECTION NIVA


FROM CHART C-4 PAGE 1 OF 2
• USING DIGITAL VOLT OHM AMP MULTIMETER KIT J 39689 TO CHECK THE RESISTANCE OF EACH PLUG CABLE OF THE COIL WHICH DID NOT FIRE THE SPARK TESTER.
• CABLE RESISTANCE SHOULD BE LESS THAN 15,000 OHMS EACH AND WIRES SHOULD NOT BE GROUNDED.
ARE CABLES OK?
YES
NO
REPLACE FAULTY CABLE(S).
• MEASURE SECONDARY RESISTANCE OF IGNITION COIL BY CONNECTING EACH MULTIMETER LEAD ON EACH COIL TOWER TERMINAL.
IS RESISTANCE BETWEEN 5000 AND 7000 OHMS?
YES
NO
FAULTY IGNITION COIL.
6
• REMOVE COIL RETAINING NUTS AND REMOVE COIL.
• COIL SHOULD BE FREE OF CARBON TRACKING.
ARE THEY?
YES
NO
REPLACE IGNITION COIL. ALSO CHECK FOR FAULTY SPARK PLUG CABLE CONNECTION(S) AND WIRE NIPPLE(S) FOR CARBON TRACKING.
• MEASURE PRIMARY RESISTANCE OF IGNITION COIL BY CONNECTING EACH MULTIMETER LEAD ON EACH FEMALE TERMINAL ON BOTTOM OF IGNITION COIL.
IS RESISTANCE BETWEEN 0.3Ω AND 1.5Ω?
YES
NO
FAULTY CONNECTION OR FAULTY IGNITION COIL.
7
• USE TEST LIGHT J 34142-B AND CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 TO JUMPER TEST LIGHT ACROSS IGNITION MODULE TERMINALS WHICH CONNECT TO IGNITION COIL PRIMARY TERMINALS.
• CRANK THE ENGINE WHILE OBSERVING TEST LIGHT.
DOES TEST LIGHT BLINK?
YES
NO
FAULTY IGNITION COIL TERMINAL CONNECTIONS OR FAULTY IGNITION COIL.
FAULTY IGNITION MODULE.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

4-27-93
NS 15201

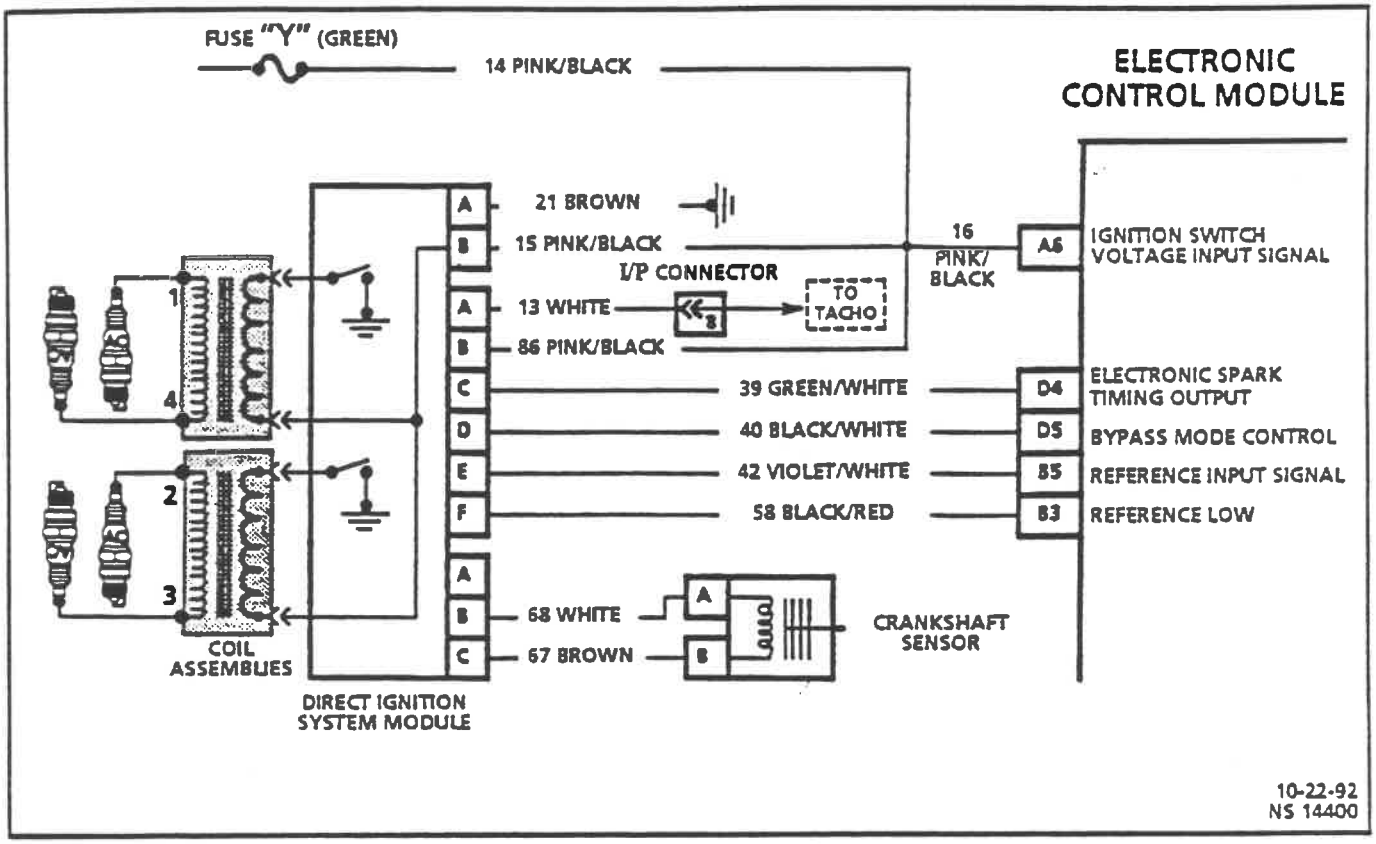


CHART C-4B

(Page 1 of 2)
DIRECT IGNITION SYSTEM MISFIRE AT IDLE
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The direct ignition system uses a waste spark method of distribution. In this type of system, the ignition module triggers the #1/4 coil pair resulting in both #1 and #4 spark plugs firing at the same time. #1 cylinder is on the compression stroke at the same time #4 is on the exhaust stroke, resulting in a lower energy requirement to fire #4 spark plug. This leaves the remainder of the high voltage to be used to fire #1 spark plug. On this application, the crankshaft position sensor is mounted to the engine block and protrudes to within approximately .1 mm of the crankshaft reluctor. Since the reluctor is a machined portion of the crankshaft pulley and the crank sensor is mounted in a fixed position on the block, timing adjustments are not possible or necessary.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. If the "Misfire" complaint exists *under load only*, diagnostic CHART C-4C must be used. Engine rpm should drop approximately equally on all plug leads.
2. A secondary ignition voltage ignition tester J 26792 (ST-125) must be used because it is essential to verify adequate available secondary voltage at the spark plug (25,000 volts).
3. If the spark jumps the test gap after grounding the opposite plug wire, it indicates excessive resistance in the plug which was bypassed. A faulty or poor connection at that plug could also result in the miss condition. Also check for carbon deposits inside the spark plug boot.

CHART C-4B

(Page 1 of 2)
DIRECT IGNITION SYSTEM
MISFIRE AT IDLE
1.7L THROTTLE BODY
INJECTION NIVA

1

- IF ENGINE MISFIRES UNDER LOAD ONLY, SEE CHART C-4C.
- IGNITION "OFF."
- DISCONNECT EACH SPARK PLUG CABLE FROM SPARK PLUG.
- INSTALL HIGH CARBON CONTENT VACUUM HOSE APPROXIMATELY 5 CM LONG ON SPARK PLUG AND CONNECT SPARK PLUG LEAD TO OTHER END OF VACUUM HOSE (VACUUM HOSE PIECES FOUND IN TERMINAL TEST ADAPTER KIT J 35616.)
- CONNECT TECH 1. SELECT "FØ: DATA LIST."
- ENGINE IDLING AT NORMAL OPERATING TEMPERATURE, DISCONNECT IDLE AIR CONTROL VALVE.
- WITH TEST LIGHT J 34142-B CONNECTED TO GROUND MOMENTARILY TOUCH EACH VACUUM HOSE, WHILE OBSERVING "ENGINE SPEED" ON TECH 1. SEE CAUTION★.
- WHEN THE TEST LIGHT CONTACTS EACH VACUUM HOSE IT SHOULD RESULT IN AN ENGINE SPEED DROP.
  DID THEY?

YES → SEE "ROUGH, UNSTABLE OR INCORRECT IDLE OR STALLING" IN "SYMPTOMS" SECTION "B".

NO

2

- WITH IGNITION "OFF," INSTALL SECONDARY IGNITION VOLTAGE IGNITION TESTER J 26792 (ST-125) ON PLUG CABLE(S) WHOSE SHORT TO GROUND THROUGH TEST LIGHT DID NOT RESULT IN ENGINE SPEED DROP.
- SPARK SHOULD JUMP SECONDARY IGNITION VOLTAGE IGNITION TESTER GAP WHILE CRANKING ENGINE.
  DOES IT?

YES

CHECK FOR:
- FAULTY, WORN OR CRACKED SPARK PLUG(S).
- PLUG FOULING DUE TO ENGINE MECHANICAL FAULT. IF SPARK PLUGS CHECK OUT OK, SEE "CUTS OUT, MISSES" IN "SYMPTOMS" SECTION "2".

NO

3

- WITH IGNITION "OFF," USING CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 GROUND THE OPPOSITE PLUG CABLE OF THE AFFECTED COIL AT SPARK PLUG.
- SPARK SHOULD JUMP SECONDARY IGNITION VOLTAGE IGNITION TESTER GAP WHILE CRANKING ENGINE.
  DOES IT?

YES

REPLACE THE SPARK PLUG FOR THE CABLE WHICH WAS JUMPERED TO GROUND. IF MISFIRE IS STILL PRESENT, START MISFIRE TEST AGAIN AT STEP #1.

NO

CONTINUE TO PAGE 2 OF 2

★ **CAUTION:** When handling secondary spark plug cables with engine running, insulated pliers must be used and care exercised to prevent a possible electrical shock.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

4-27-93
NS 15804

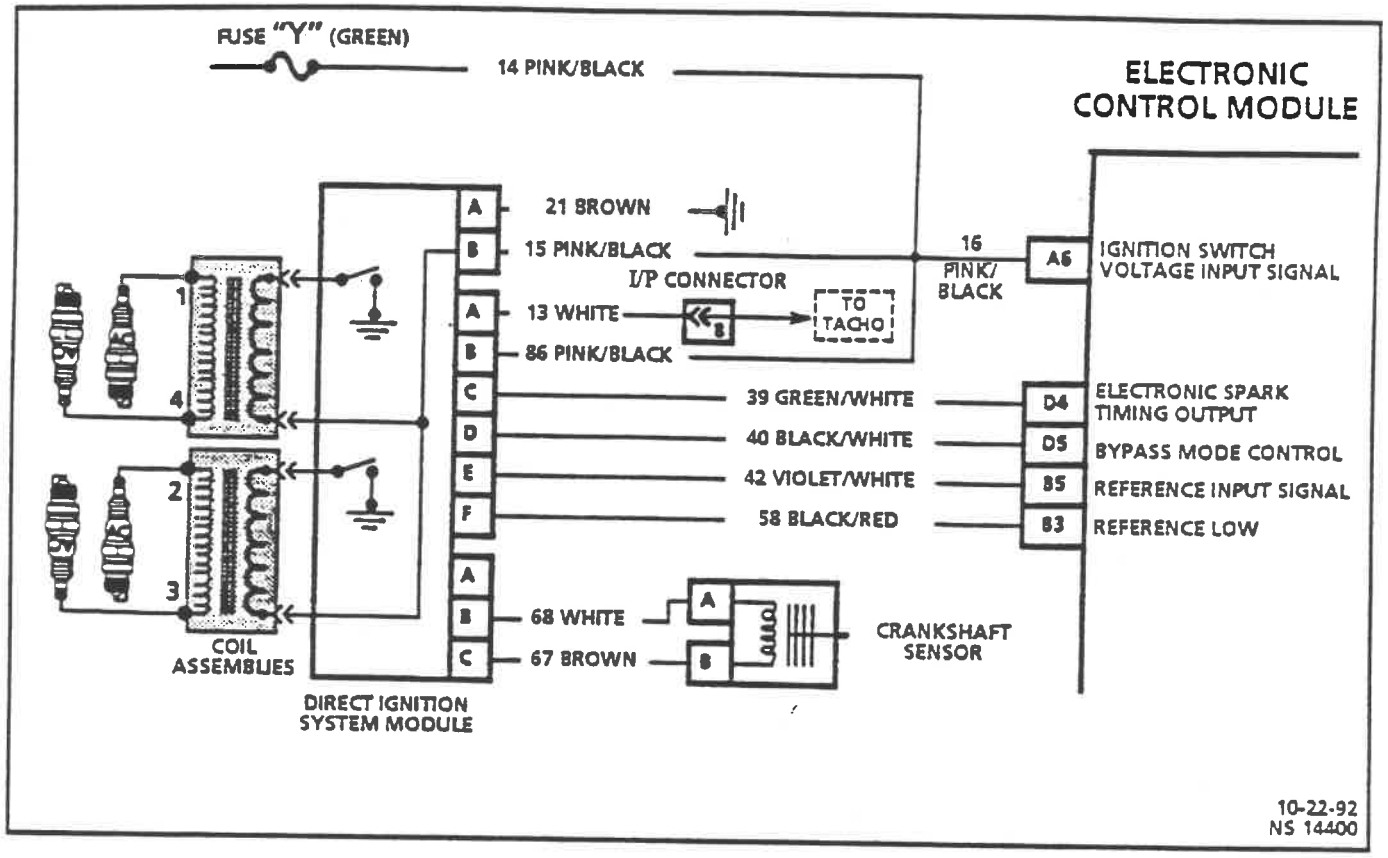


CHART C-4B

(Page 2 of 2)
DIRECT IGNITION SYSTEM MISFIRE AT IDLE
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The direct ignition system uses a waste spark method of distribution. In this type of system, the ignition module triggers the #1/4 coil pair resulting in both #1 and #4 spark plugs firing at the same time. #1 cylinder is on the compression stroke at the same time #4 is on the exhaust stroke, resulting in a lower energy requirement to fire #4 spark plug. This leaves the remainder of the high voltage to be used to fire #1 spark plug. On this application, the crankshaft position sensor is mounted to the engine block and protrudes to within approximately .050" of the crankshaft reluctor. Since the reluctor is a machined portion of the crankshaft pulley and the crank sensor is mounted in a fixed position on the block, timing adjustments are not possible or necessary.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

4. To check the spark plug cable, use the digital multimeter J 39689 on the ohms scale. Disconnect the suspect spark plug cable from both ends and connect one of the multimeter probes to each end of the plug cable.
5. If carbon tracking is evident, replace coil and be sure plug cables relating to that coil are clean and tight. Excessive cable resistance or faulty connections could have caused the coil to be damaged.
6. If the "no spark" condition follows the suspected coil, that coil is faulty. Otherwise, the ignition module is the cause of no spark. This test could also be performed by substituting a known good coil for the one causing the "no spark" condition.

CHART C-4B

(Page 2 of 2)
DIRECT IGNITION SYSTEM
MISFIRE AT IDLE
1.7L THROTTLE BODY
INJECTION NIVA

FROM PAGE 1 OF 2

4. • CHECK THE RESISTANCE OF EACH PLUG CABLE OF THE COIL WHICH DID NOT FIRE THE SECONDARY IGNITION VOLTAGE IGNITION TESTER.
   • CABLE RESISTANCE SHOULD BE LESS THAN 15,000 OHMS EACH AND CABLES SHOULD NOT BE GROUNDED.
   ARE CABLES OK?

   YES

5. • REMOVE COIL RETAINING NUTS AND REMOVE COILS.
   • COILS SHOULD BE FREE OF CARBON TRACKING.
   ARE THEY?

   YES

6. • SWITCH A NORMALLY OPERATING COIL WITH THE COIL FROM PROBLEM CYLINDER.
   • SPARK SHOULD JUMP SECONDARY IGNITION VOLTAGE IGNITION TESTER GAP AT PROBLEM CYLINDER WHILE CRANKING ENGINE.
   DID IT?

   YES

ORIGINAL IGNITION COIL IS FAULTY.

NO

REPLACE FAULTY CABLE(S).

NO

REPLACE IGNITION COIL. ALSO CHECK FOR FAULTY PLUG CABLE CONNECTION(S) AND CABLE NIPPLE(S) FOR CARBON TRACKING.

NO

REPLACE ELECTRONIC IGNITION MODULE.

★ **CAUTION:** When handling secondary spark plug cables with engine running, insulated pliers must be used and care exercised to prevent a possible electrical shock.

"AFTER REPAIRS," START ENGINE. CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

4-27-93
NS 14450

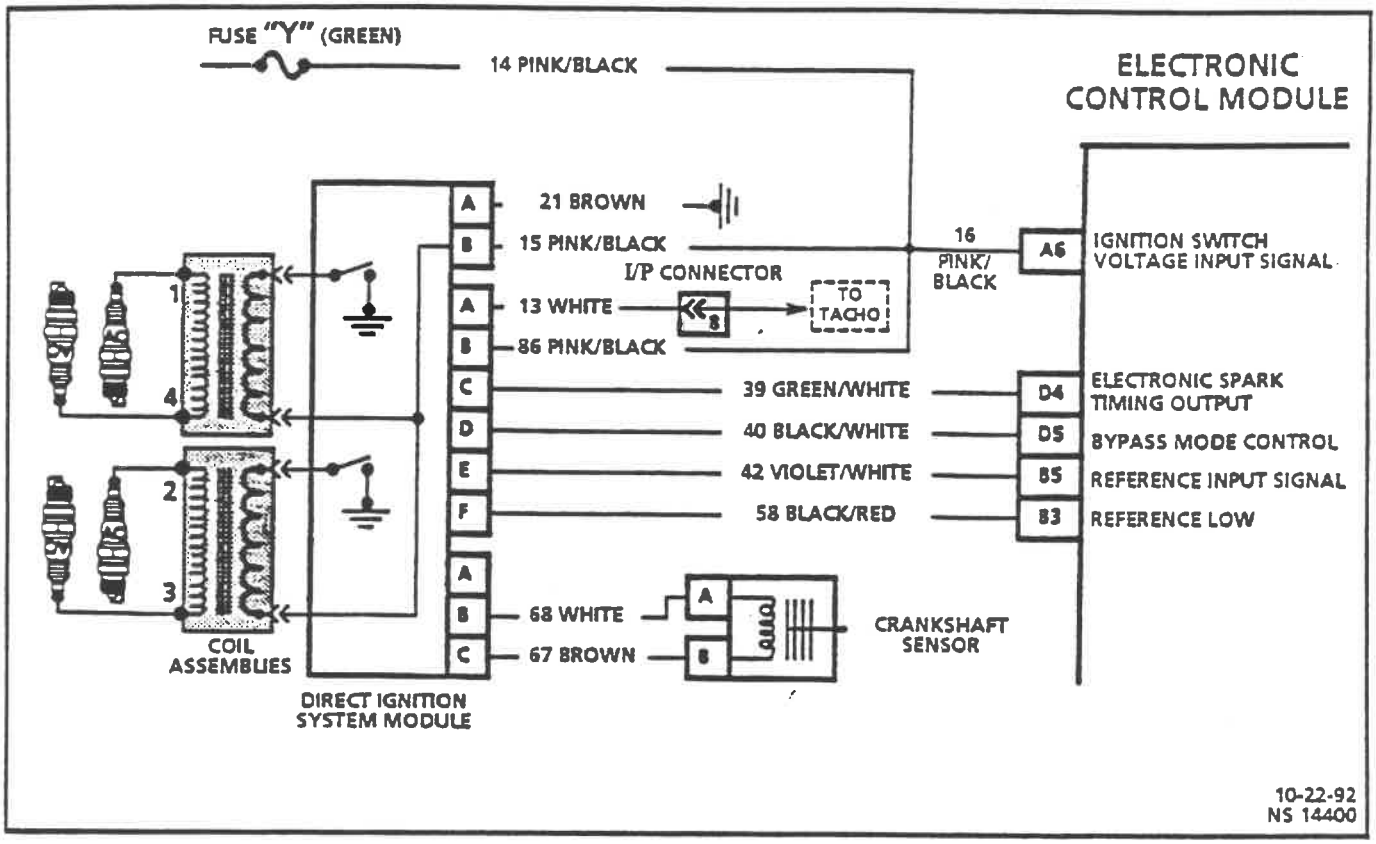


CHART C-4C

DIRECT IGNITION SYSTEM MISFIRE UNDER LOAD
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

The direct ignition system uses a waste spark method of distribution. In this type of system, the ignition module triggers the #1/4 coil pair resulting in both #1 and #4 spark plugs firing at the same time. #1 cylinder is on the compression stroke at the same time #4 is on the exhaust stroke, resulting in a lower energy requirement to fire #4 spark plug. This leaves the remainder of the high voltage to be used to fire #1 spark plug. On this application the crankshaft position sensor is mounted to the engine block and protrudes to within approximately .050" of the crankshaft reluctor. Since the reluctor is a machined portion of the crankshaft and the crankshaft sensor is mounted in a fixed position on the block, timing adjustments are not possible or necessary.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. If the "Misfire" complaint exists *at idle only*, diagnostic CHART C-4B must be used. A secondary ignition voltage ignition tester J 26792 (ST-125) must be used because it is essential to verify adequate available secondary voltage at the spark plug (25,000 volts). Spark should jump the test gap on all 4 leads. This simulates a "load" condition.
2. If the spark jumps secondary ignition voltage ignition tester J 26792 (ST-125) gap after grounding the opposite plug wire, it indicates excessive resistance in the plug which was bypassed. A faulty or poor connection at that plug could also result in the miss condition. Also check for carbon deposits inside the spark plug boot.
3. If carbon tracing is evident, replace coil and be sure plug wires relating to that coil are clean and tight. Excessive wire resistance or faulty connections could have caused the coil to be damaged.
4. If the no spark condition follows the suspected coil, that coil is faulty. Otherwise, the ignition module is the cause of no spark. This test could also be performed by substituting a known good coil for the one causing the no spark condition.

CHART C-4C

DIRECT IGNITION SYSTEM MISFIRE UNDER LOAD 1.7L THROTTLE BODY INJECTION NIVA

1

- IF ENGINE MISFIRES AT IDLE ONLY, SEE CHART C-4B.
- IGNITION "OFF."
- DISCONNECT ONE SPARK PLUG LEAD AT A TIME AND, INSTALL SECONDARY IGNITION VOLTAGE IGNITION TESTER J 26792 (ST-125).
- OBSERVE SECONDARY IGNITION VOLTAGE IGNITION TESTER WITH ENGINE IDLING. REPEAT THIS TEST FOR ALL PLUG CABLES. SEE CAUTION ★
- SPARK SHOULD JUMP SECONDARY IGNITION VOLTAGE IGNITION TESTER GAP ON ALL CABLES WITH ENGINE IDLING. DID IT?

NO

2

- WITH IGNITION "OFF," USE CONNECTOR TERMINAL TEST ADAPTER KIT J 35616 GROUND THE OPPOSITE PLUG CABLE OF THE AFFECTED COIL AT SPARK PLUG.
- SPARK SHOULD JUMP SECONDARY IGNITION VOLTAGE IGNITION TESTER GAP WHILE CRANKING ENGINE. DOES IT?

YES

CHECK FOR:
- FAULTY, WORN OR CRACKED SPARK PLUG(S).
- PLUG FOULING DUE TO ENGINE MECHANICAL FAULT.

IF SPARK PLUGS CHECK OUT OK, SEE "CUTS OUT, MISSES" IN "SYMPTOMS," SECTION "2-8".

NO

- CHECK THE RESISTANCE OF EACH PLUG CABLE OF THE COIL WHICH DID NOT FIRE THE SECONDARY IGNITION VOLTAGE IGNITION TESTER.
- CABLE RESISTANCE SHOULD BE LESS THAN 15,000 OHMS EACH AND CABLES SHOULD NOT BE GROUNDED. ARE CABLES OK?

YES

REPLACE THE SPARK PLUG FOR THE CABLE WHICH WAS JUMPERED TO GROUND. IF MISFIRE IS STILL PRESENT, START MISFIRE TEST AGAIN AT STEP #1.

YES

3

- REMOVE COIL RETAINING NUTS AND REMOVE COILS.
- COILS SHOULD BE FREE OF CARBON TRACKING. ARE THEY?

NO

REPLACE FAULTY CABLE(S).

YES

4

- SWITCH A NORMALLY OPERATING COIL WITH THE COIL FROM PROBLEM CYLINDER.
- SPARK SHOULD JUMP SECONDARY IGNITION VOLTAGE IGNITION TESTER GAP WITH ENGINE IDLING. DID IT?

NO

REPLACE IGNITION COIL. ALSO CHECK FOR FAULTY PLUG CABLE CONNECTIONS AND CABLE NIPPLES FOR CARBON TRACKING.

YES

ORIGINAL IGNITION COIL IS FAULTY.

NO

REPLACE ELECTRONIC IGNITION MODULE.

★ **CAUTION:** When handling secondary spark plug cables with engine running, insulated pliers must be used and care exercised to prevent a possible electrical shock.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

6-2-92
NS 14380

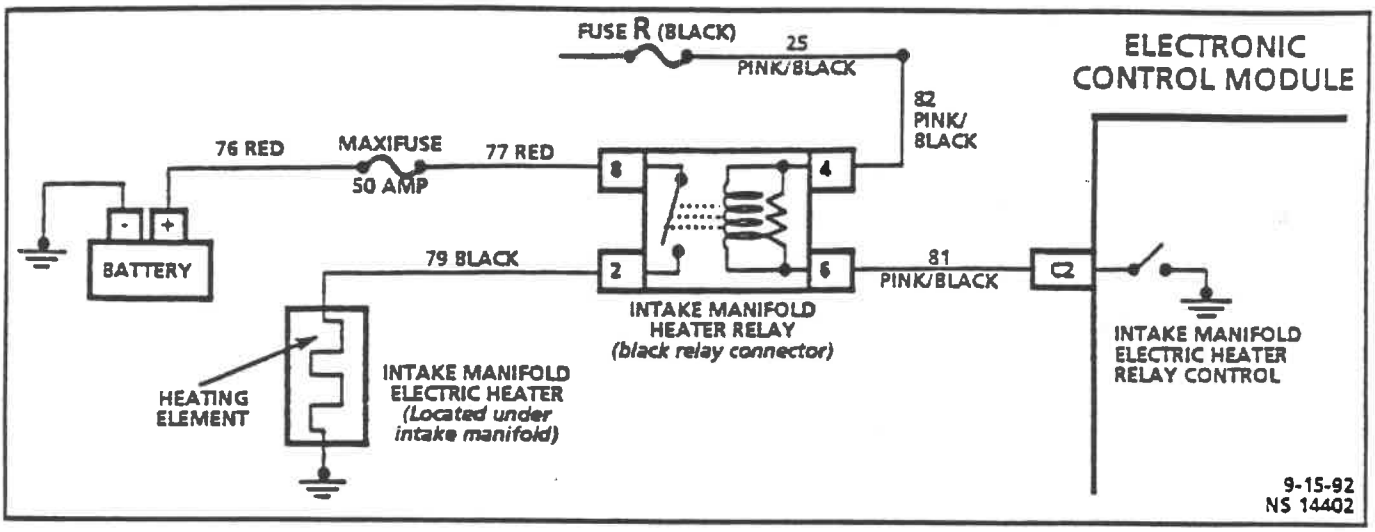


CHART C-9

(Page 1 of 2)
INTAKE MANIFOLD ELECTRIC HEATER
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

To assist in cold driveability, the electronic control module controls a positive temperature coefficient heater. This electric heating element is turned "ON" by the electronic control module by supplying a ground to a control relay at the electronic control module's terminal "C2". The relay completes the circuit and supplies voltage from a 50 amp maxi fuse to the heater.

The heating element is self-current limiting, as its temperature increases its resistance increases, preventing thermal overheat and possible resultant short to ground.

The electronic control module switches "ON" the heater based upon various inputs and conditions:

- Coolant temperature sensor is less than 63°C.
- Engine is running.
- Intake air temperature is less than 80°C.
- Battery voltage is greater than 8 volts.

Once the heater has been "ON" the electronic control module will turn it "OFF," if the following conditions exist:

- Battery voltage is less than 6 volts. (Heavy electrical accessory load.)
- Coolant temperature sensor input is greater than 65°C.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

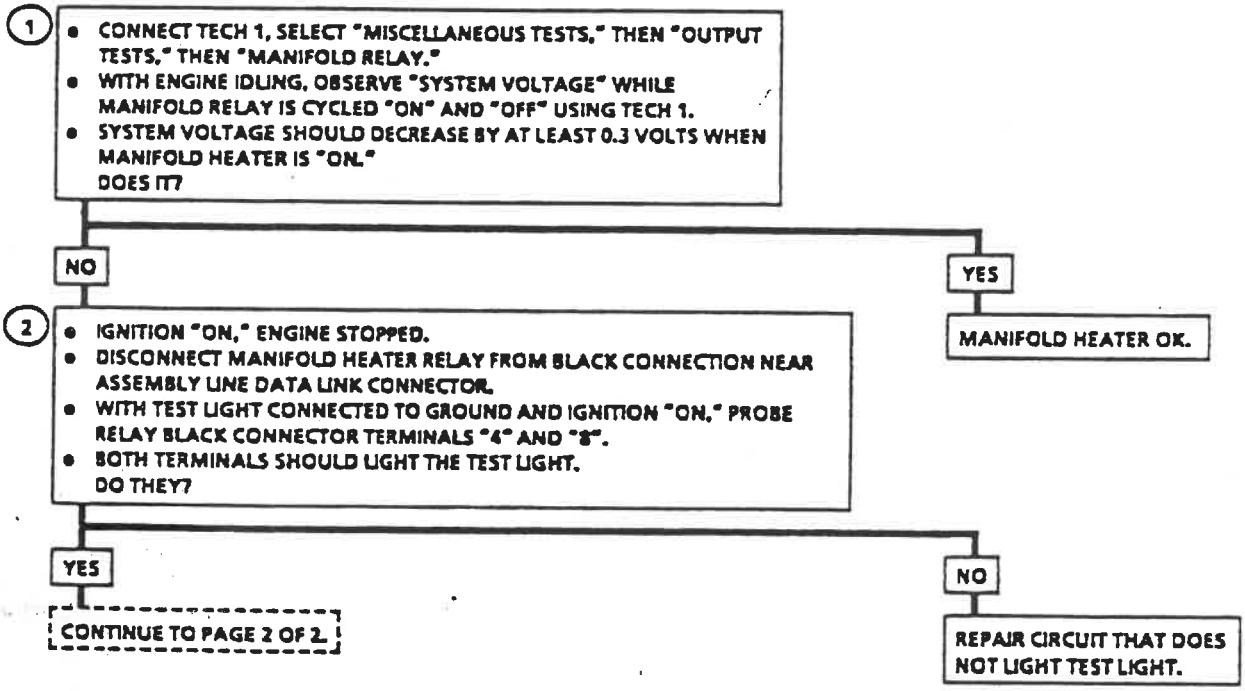
1. By using the Tech 1 "Scan" tool this quick check of the intake manifold heater can be performed. (See Diagnostic Aids.)
2. This step checks for power on relay control and load circuits.

Diagnostic Aids:

With ignition "ON," engine running, use Tech 1 "OUTPUT TEST" to turn "ON" heater. Observe "System Voltage" on Tech 1. System voltage should drop at least 0.3 volts with heater "ON." Engine must be idling for this Tech 1 command to take effect.

CHART C-9

(Page 1 of 2)
INTAKE MANIFOLD ELECTRIC HEATER
1.7L THROTTLE BODY INJECTION NIVA


1
• CONNECT TECH 1, SELECT "MISCELLANEOUS TESTS," THEN "OUTPUT TESTS," THEN "MANIFOLD RELAY."
• WITH ENGINE IDLING, OBSERVE "SYSTEM VOLTAGE" WHILE MANIFOLD RELAY IS CYCLED "ON" AND "OFF" USING TECH 1.
• SYSTEM VOLTAGE SHOULD DECREASE BY AT LEAST 0.3 VOLTS WHEN MANIFOLD HEATER IS "ON."
DOES IT?
NO
YES
MANIFOLD HEATER OK.
2
• IGNITION "ON," ENGINE STOPPED.
• DISCONNECT MANIFOLD HEATER RELAY FROM BLACK CONNECTION NEAR ASSEMBLY LINE DATA LINK CONNECTOR.
• WITH TEST LIGHT CONNECTED TO GROUND AND IGNITION "ON," PROBE RELAY BLACK CONNECTOR TERMINALS "4" AND "8".
• BOTH TERMINALS SHOULD LIGHT THE TEST LIGHT.
DO THEY?
YES
CONTINUE TO PAGE 2 OF 2.
NO
REPAIR CIRCUIT THAT DOES NOT LIGHT TEST LIGHT.

9-25-92
NS 15805

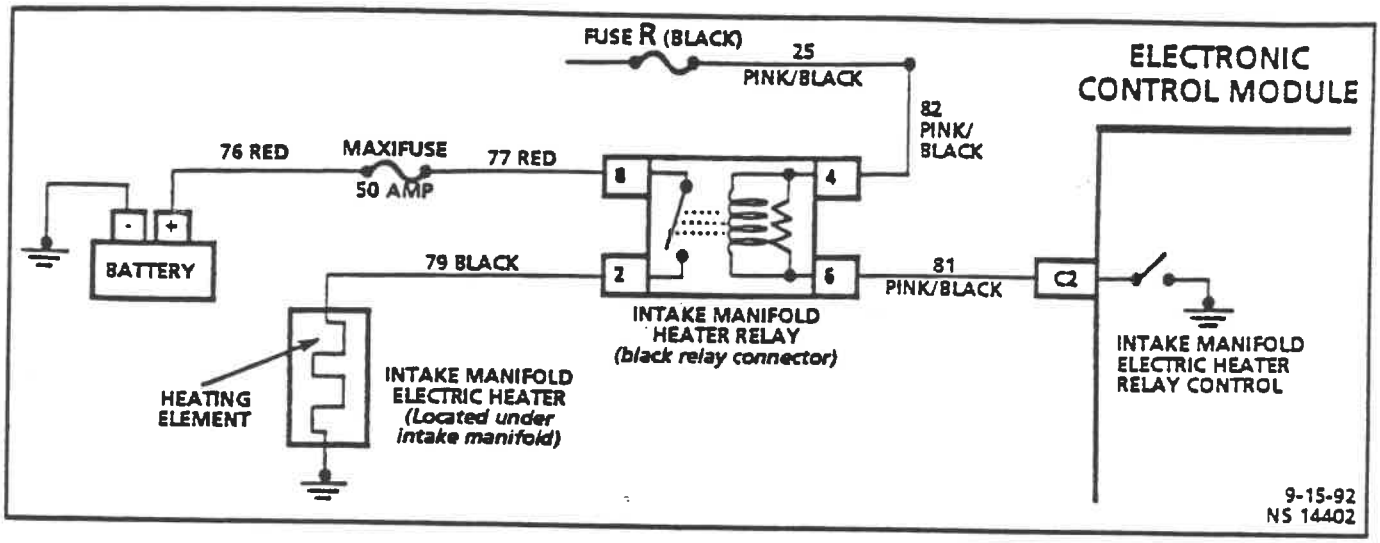


CHART C-9

(Page 2 of 2)
INTAKE MANIFOLD ELECTRIC HEATER
1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

To assist in cold driveability, the electronic control module controls a positive temperature coefficient heater. This electric heating element is turned "ON" by the electronic control module by supplying a ground to a control relay at the electronic control module's terminal "C2". The relay completes the circuit and supplies voltage from a 50 amp maxi fuse to the heater.

The heating element is self-current limiting, as its temperature increases its resistance increases, preventing thermal overheat and possible resultant short to ground.

The electronic control module switches "ON" the heater based upon various inputs and conditions:

- Coolant temperature sensor is less than 63°C.
- Engine is running.
- Intake air temperature is less than 80°C.
- Battery voltage is greater than 8 volts.

Once the heater has been "ON" the electronic control module will turn it "OFF," if the following conditions exist:

- Battery voltage is less than 6 volts. (Heavy electrical accessory load.)
- Coolant temperature sensor input is greater than 65°C.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

3. Heater must be tested at or about 27°C. As the heater warms from 27°C its resistance increases. If necessary, remove and cool the heater. The heater's resistance at 27°C should be less than 0.3 ohms.
4. This step checks Circuit 79 wire.
5. This step simulates electronic control module control of relay.
6. This step will determine if the electronic control module is defective or if Circuit 81 is faulty.

Diagnostic Aids:

With ignition "ON," engine running, use Tech 1 "OUTPUT TEST" to turn "ON" heater. Observe "System Voltage" on Tech 1. System voltage should drop at least 0.3 volts with heater "ON." Engine must be idling for this Tech 1 command to take effect.

CHART C-9

(Page 2 of 2)
INTAKE MANIFOLD ELECTRIC HEATER
1.7L THROTTLE BODY INJECTION NIVA

CONTINUED FROM PAGE 1 OF 2

3
- DISCONNECT MANIFOLD HEATER ELECTRICAL CONNECTOR. PERFORM NEXT STEP WITH HEATER AT ROOM TEMPERATURE.
- USING DIGITAL OHMMETER, MEASURE RESISTANCE FROM HEATER CONNECTOR TO ENGINE BLOCK. SHOULD BE BETWEEN 0.3 AND 0.5 OHMS. IS IT?

YES

4
- IF REMOVED AT PREVIOUS STEP, REINSTALL HEATER INTO INTAKE MANIFOLD.
- RECONNECT HEATER ELECTRICAL CONNECTOR.
- USING DIGITAL OHMMETER, MEASURE RESISTANCES BETWEEN RELAY CONNECTOR TERMINAL "2" AND ENGINE BLOCK GROUND.
- RESISTANCE SHOULD NOT BE ZERO AND SHOULD BE APPROXIMATELY THE SAME AS MEASURED IN STEP 3.
WHAT IS THE RESISTANCE?

NO

CHECK INTAKE MANIFOLD HEATER HOLD DOWN BOLTS FOR CORROSION. ALSO INSURE THAT THEY ARE TIGHT. RECHECK RESISTANCE, IF STILL OVER SPECIFICATION REPLACE INTAKE MANIFOLD HEATER. RECHECK RESISTANCE. IF STILL OVER SPECIFICATION REPLACE INTAKE MANIFOLD HEATER.

APPROXIMATELY SAME AS STEP 3

ALMOST ZERO OHMS

REPAIR SHORT TO GROUND IN CIRCUIT 79 BLACK WIRE BETWEEN HEATER CONNECTOR AND RELAY CONNECTOR.

OPEN CIRCUIT, NO CONTINUITY

REPAIR OPEN CIRCUIT IN BLACK WIRE BETWEEN HEATER CONNECTOR AND BLACK RELAY CONNECTOR TERMINAL "2".

5
- CONNECT TEST LIGHT BETWEEN +12 VOLTS AND RELAY CONNECTOR TERMINAL "6".
- ENGINE IDLING, USE TECH 1 "OUTPUT TEST" TO TURN "ON" MANIFOLD HEATER RELAY CONTROL FROM ELECTRONIC CONTROL MODULE.
- TEST LIGHT SHOULD LIGHT.
DOES IT?

YES

REPLACE RELAY WITH NEW RELAY AND RETEST AT STEP 1.

NO

6
- CONNECT TEST LIGHT BETWEEN +12 VOLTS AND ELECTRONIC CONTROL MODULE TERMINAL "C2".
- ENGINE IDLING.
- USE TECH 1 OUTPUT TEST" TO TURN "ON" AND "OFF" MANIFOLD HEATER RELAY CONTROL
- TEST LIGHT SHOULD TURN "ON" AND "OFF."
WHAT DOES TEST LIGHT DO?

TURNS "ON" AND "OFF"

REPAIR OPEN CIRCUIT 80 PINK/BLACK WIRE, BETWEEN ELECTRONIC CONTROL MODULE AND RELAY CONNECTOR.

STAYS "ON"

REPAIR SHORT TO GROUND IN CIRCUIT 80 PINK/BLACK WIRE BETWEEN ELECTRONIC CONTROL MODULE AND RELAY CONNECTOR.

STAYS "OFF"

REPLACE ELECTRONIC CONTROL MODULE.

11-3-92
NS 13532

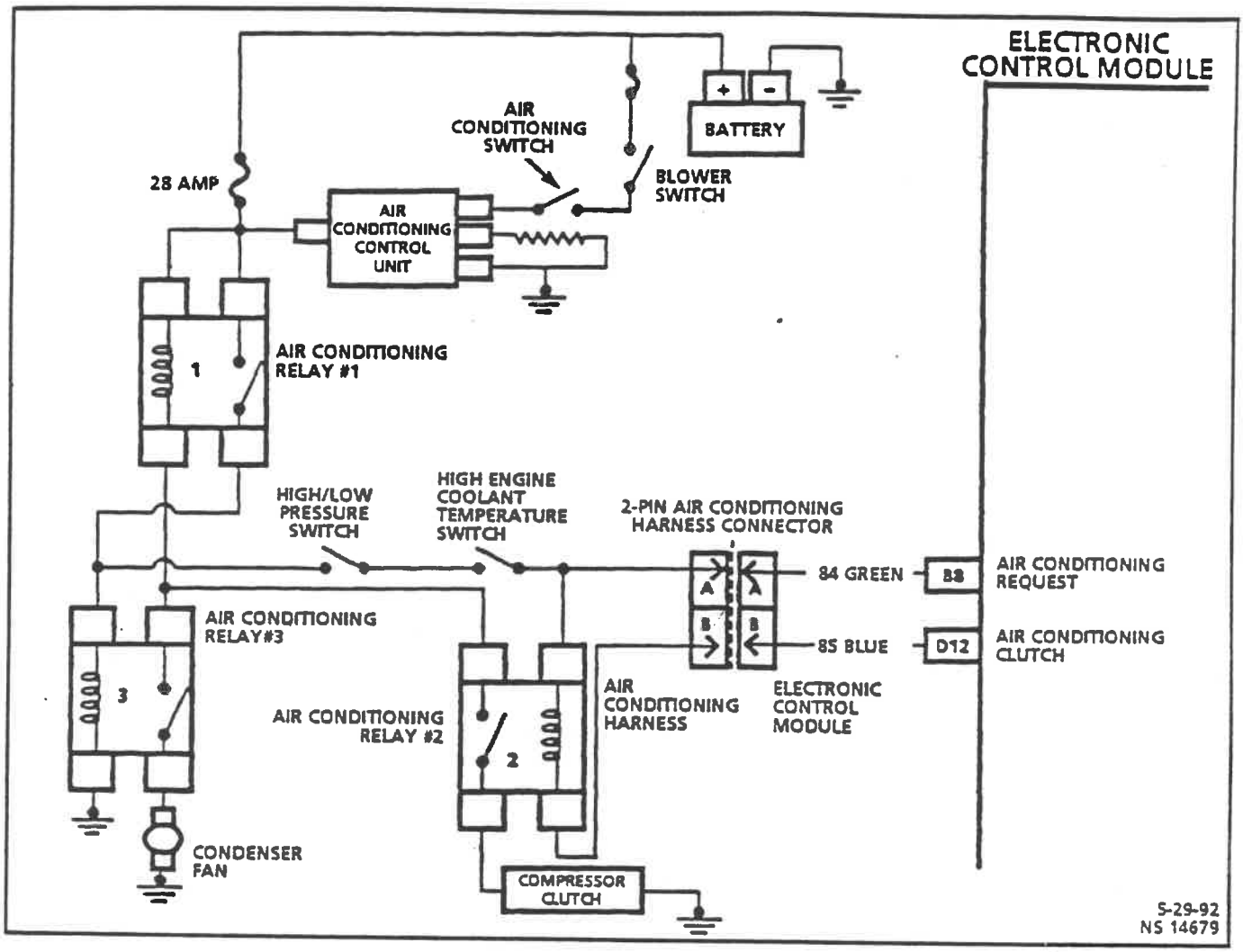


CHART C-10

AIR CONDITIONING COMPRESSOR CLUTCH CONTROL 1.7L THROTTLE BODY INJECTION NIVA

Circuit Description:

A request for air conditioning is sensed by the electronic control module. When it has + 12 volts applied to terminal "B8". When the electronic control module senses the air conditioning is requested, it will energize the air conditioning Compressor Clutch Control relay by providing a ground path for the coil part of the relay. The relay contacts will close, and current will flow from the relay and engage the air conditioning Compressor Clutch.

The electronic control module de-energizes the relay under the following conditions:

- If the throttle position sensor is greater than about 95%.
- No air conditioning requested.
- Coolant temperature is above about 112°C.
- Engine speed is above about 6375 revolutions per minute.
- Vehicle speed less than 7 km/h and throttle position greater than 50%.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. The air conditioning compressor clutch should not engage until about 0.3 second after the output test is enabled.
2. With engine idling and air conditioning dash switch "ON," the electronic control module should be grounding the relay control circuit causing the test light to be "ON."

Diagnostic Aids:

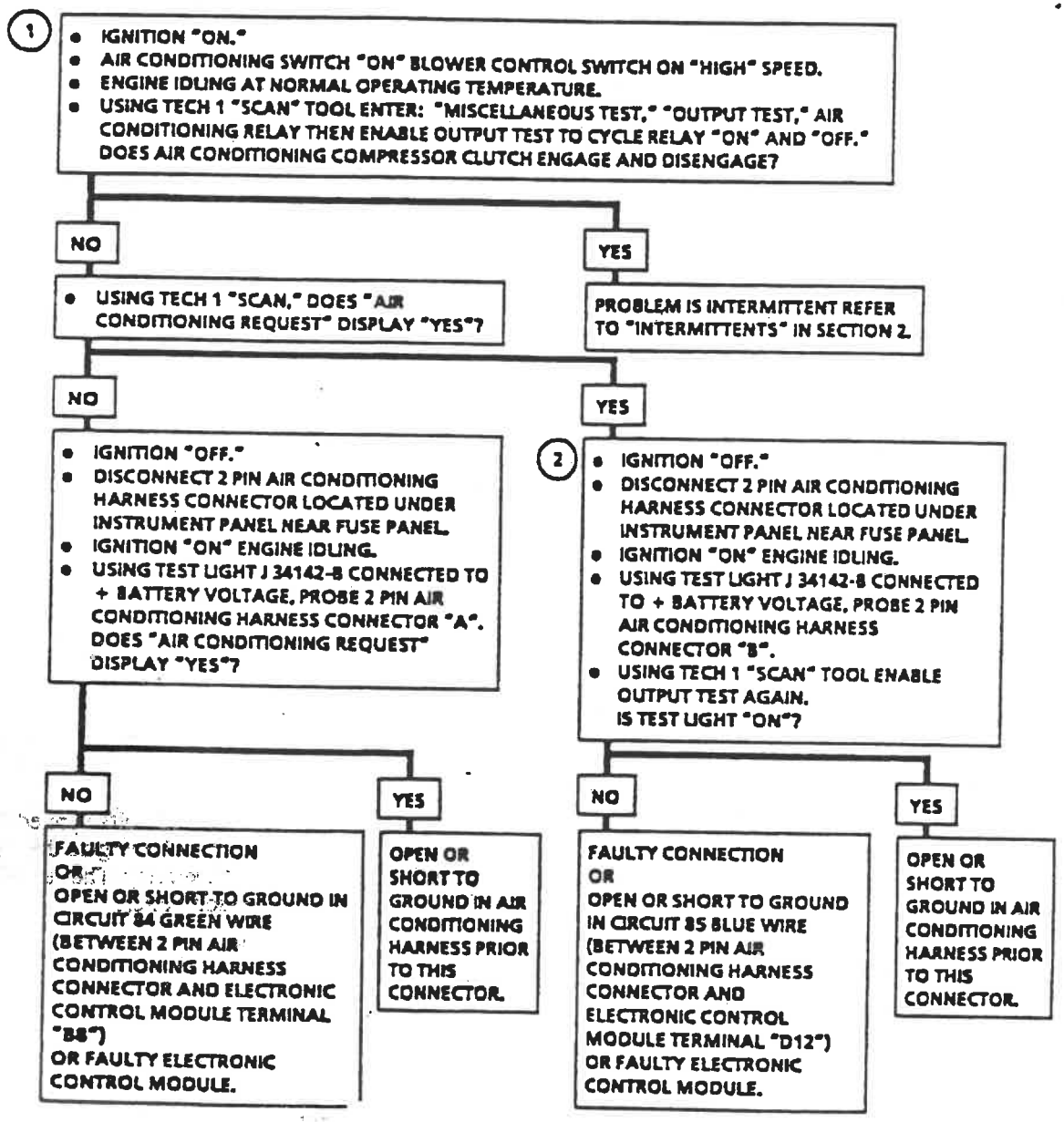
The Tech 1 "Scan" tool displays air conditioning request signal voltage at the electronic control module "B8".

A short to voltage on Circuit 84 Green wire to electronic control module terminal "B8" will display air conditioning request "Yes" in all positions of dash switch.

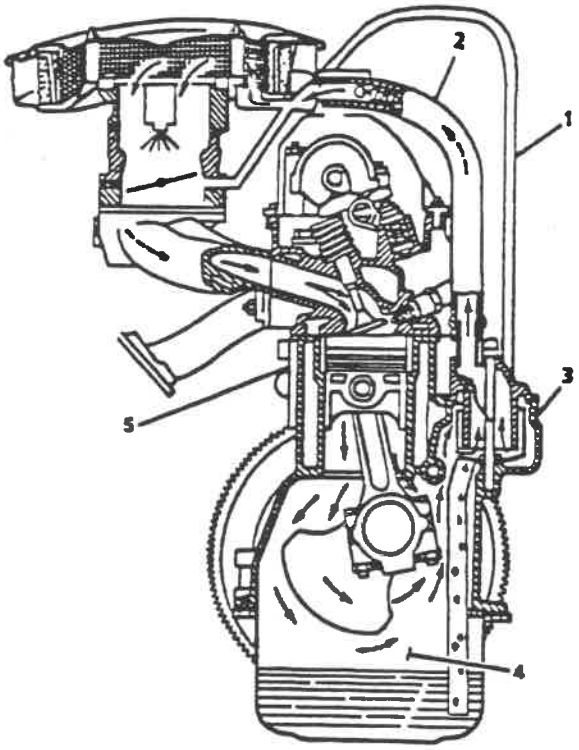
THIS CHART ASSUMES THE AIR CONDITIONING SYSTEM IS FULLY CHARGED AND IS IN PROPER WORKING CONDITION

CHART C-10

AIR CONDITIONING COMPRESSOR CLUTCH CONTROL 1.7L THROTTLE BODY INJECTION NIVA


1
• IGNITION "ON."
• AIR CONDITIONING SWITCH "ON" BLOWER CONTROL SWITCH ON "HIGH" SPEED.
• ENGINE IDLING AT NORMAL OPERATING TEMPERATURE.
• USING TECH 1 "SCAN" TOOL ENTER: "MISCELLANEOUS TEST," "OUTPUT TEST," AIR CONDITIONING RELAY THEN ENABLE OUTPUT TEST TO CYCLE RELAY "ON" AND "OFF." DOES AIR CONDITIONING COMPRESSOR CLUTCH ENGAGE AND DISENGAGE?
NO
YES
• USING TECH 1 "SCAN," DOES "AIR CONDITIONING REQUEST" DISPLAY "YES"?
PROBLEM IS INTERMITTENT REFER TO "INTERMITTENTS" IN SECTION 2.
NO
YES
• IGNITION "OFF."
• DISCONNECT 2 PIN AIR CONDITIONING HARNESS CONNECTOR LOCATED UNDER INSTRUMENT PANEL NEAR FUSE PANEL.
• IGNITION "ON" ENGINE IDLING.
• USING TEST LIGHT J 34142-B CONNECTED TO + BATTERY VOLTAGE, PROBE 2 PIN AIR CONDITIONING HARNESS CONNECTOR "A". DOES "AIR CONDITIONING REQUEST" DISPLAY "YES"?
2
• IGNITION "OFF."
• DISCONNECT 2 PIN AIR CONDITIONING HARNESS CONNECTOR LOCATED UNDER INSTRUMENT PANEL NEAR FUSE PANEL.
• IGNITION "ON" ENGINE IDLING.
• USING TEST LIGHT J 34142-B CONNECTED TO + BATTERY VOLTAGE, PROBE 2 PIN AIR CONDITIONING HARNESS CONNECTOR "B".
• USING TECH 1 "SCAN" TOOL ENABLE OUTPUT TEST AGAIN. IS TEST LIGHT "ON"?
NO
YES
FAULTY CONNECTION OR OPEN OR SHORT TO GROUND IN CIRCUIT 84 GREEN WIRE (BETWEEN 2 PIN AIR CONDITIONING HARNESS CONNECTOR AND ELECTRONIC CONTROL MODULE TERMINAL "B8") OR FAULTY ELECTRONIC CONTROL MODULE.
OPEN OR SHORT TO GROUND IN AIR CONDITIONING HARNESS PRIOR TO THIS CONNECTOR.
NO
YES
FAULTY CONNECTION OR OPEN OR SHORT TO GROUND IN CIRCUIT 85 BLUE WIRE (BETWEEN 2 PIN AIR CONDITIONING HARNESS CONNECTOR AND ELECTRONIC CONTROL MODULE TERMINAL "D12") OR FAULTY ELECTRONIC CONTROL MODULE.
OPEN OR SHORT TO GROUND IN AIR CONDITIONING HARNESS PRIOR TO THIS CONNECTOR.

5-28-92
NS 14451



1 PRIMARY CIRCUIT

2 SECONDARY CIRCUIT

3 OIL SEPARATOR

4 CRANKCASE VAPORS

5 COMBUSTION CHAMBER

NS 14680

CHART C-13

CRANKCASE VENTILATION SYSTEM CHECK 1.7L THROTTLE BODY INJECTION NIVA

System Description:

The crankcase ventilation system has 2 circuits. In both circuits crankcase vapors are returned to the combustion chamber through an oil separator located on the engine block near the ignition module. The primary circuit consists of a calibrated orifice fitted into the intake manifold just below the throttle body injection unit. A small hose runs from this orifice to the oil separator. A larger secondary circuit hose runs from the air cleaner to the oil separator.

At idle, all crankcase vapors are directed through the primary circuit orifice (small hose), which will be experiencing high vacuum. Under heavy load or wide open throttle conditions a small amount of crankcase vapors are passed through the primary system orifice. However, most vapors pass through the secondary system (large hose), into the air cleaner, through the throttle body injection and are burned in the combustion chamber.

RESULTS OF INCORRECT OPERATION:

A plugged hose may cause:

- Higher than normal idle air control steps.
- Oil leaks.
- Oil in air cleaner.
- Sludge in engine.

CHART C-13

CRANKCASE VENTILATION SYSTEM CHECK 1.7L THROTTLE BODY INJECTION NIVA

DIAGNOSIS

FUNCTIONAL CHECK OR VENTILATION SYSTEM

There are no moving parts in the ventilation system. Maintenance consists of inspecting the hoses to make sure they are clear and in good operating condition. The vacuum orifice in the manifold should be inspected on a regular basis to be sure it is not plugged, and cleaned if necessary.

Proper operation of the ventilation system is dependent upon a sealed engine. If oil sludging or dilution is noted, and the ventilation system is functioning properly, check engine for possible cause and correct to ensure that system will function as intended.

11-5-91
MS 11545

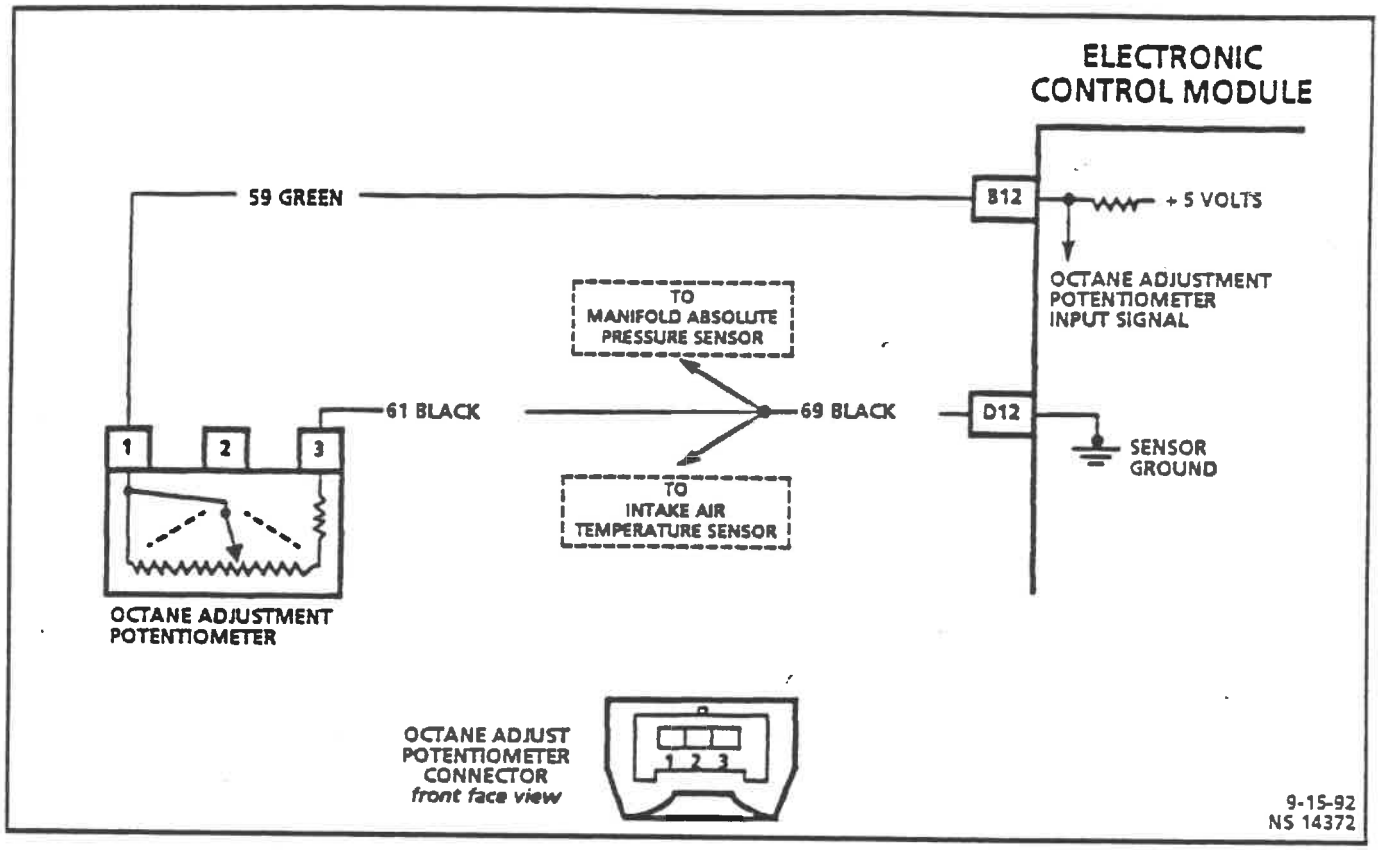


CHART C-15

OCTANE ADJUSTMENT POTENTIOMETER CHECK 1.7L THROTTLE BODY INJECTION NIVA

System Description:

The octane adjustment potentiometer is a dealer only adjustment that compensates for the use of low octane fuel. The potentiometer is adjustable from about 1 to 4.5 volts and 0 to 8 degrees of retard. Any voltage adjustments that are made at the potentiometer provide a corresponding change in degrees of retard at the ignition system, provided the Tech 1 "Scan" tool is installed and in the "Octane Adjust" mode. Abnormally High (more than 4.9 volts) or abnormally low (less than 0.50 volts) voltage readings will cause a Code 54. While the Code 54 problem is present the "Check Engine" light will remain "ON" when the engine is running. At the same time, the electronic control module will use a substitute (value of "degrees of retard") until the problem is corrected.

No attempts at adjusting the Octane Adjust potentiometer should be made if a Code 54 is present.

Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Checks to make sure a possible Code 54 is not set.
2. Checks operation of the potentiometer.
3. Describes adjustment procedures and precautions.

NOTE: The electronic control module monitors the voltage from the potentiometer any time the ignition is "ON." This can be observed using Tech 1 in the "FØ: DATA LIST" mode when the engine is running.

However, changes to the amount of spark retard based on the potentiometer input signal will only take effect when the Tech 1 tool is used in the "Miscellaneous Tests-Octane Adjustment" mode.

CHART C-15

OCTANE ADJUSTMENT POTENTIOMETER CHECK 1.7L THROTTLE BODY INJECTION NIVA

IF CODE 54 IS DETECTED, REPAIR THE PROBLEM THAT CAUSED THE CODE 54 BEFORE USING THIS PROCEDURE.

NOTICE: THE OCTANE ADJUST POTENTIOMETER IS PRESET AT THE FACTORY FOR THE USE OF HIGH OCTANE FUEL. IN MOST CASES IT WILL NOT NEED TO BE ADJUSTED DURING THE LIFE OF THE VEHICLE. THERE ARE ONLY TWO TIMES WHEN AN ADJUSTMENT SHOULD BE MADE:

1. IF THE CUSTOMER HAS COMPLAINED OF DETONATION.
2. IF THE CUSTOMER HAS REQUESTED AN ADJUSTMENT TO COMPENSATE FOR THE ANTICIPATED USE OF LOW OCTANE FUEL.

IF AN ADJUSTMENT IS BEING MADE FOR REASONS OTHER THAN THOSE LISTED ABOVE THEN THE ADJUSTMENT IS NOT NECESSARY AND YOU SHOULD NOT PROCEED WITH THIS CHART.

(1)
- ENGINE IDLING.
- CONNECT TECH 1 "SCAN" TOOL.
- SELECT FØ DATA LIST.
- DOES TECH 1 DISPLAY "OCTANE ADJUST" VOLTS BETWEEN 1.0 AND 4.7, AND "DEGREES OF RETARD" BETWEEN 0 AND 8?

YES

(2)
- WHILE OBSERVING TECH 1 SLOWLY TURN OCTANE ADJUST POTENTIOMETER ADJUSTMENT SCREW. DOES VOLTAGE DISPLAYED ON TECH 1 RESPOND TO THE ADJUSTMENT SCREW MOVEMENT?

YES

(3)
- THE POTENTIOMETER IS SET AT THE FACTORY AT ABOUT 1 VOLT (NO RETARD ON SYSTEM).
- ENGINE IDLING. ON TECH 1 SELECT "MISC TESTS" THEN SELECT "OCTANE ADJUST."
- BEFORE YOU PROCEED YOU MUST GET TO THE "OCTANE ADJUST" MODE IN THE TECH 1. TO DO THIS YOU MUST, PRESS THE EXIT BUTTON, SELECT "MISC" TEST AND THEN "OUTPUT" TESTS. NOW SELECT "OCTANE ADJUST" AND PROCEED.
- TURN ADJUSTMENT SCREW UNTIL DESIRED VOLTAGE/AMOUNT OF RETARD IS REACHED.
- TOO MUCH RETARD CAN RESULT IN POOR PERFORMANCE AND FUEL ECONOMY. IT IS BECAUSE OF THIS THAT ONLY SMALL ADJUSTMENTS SHOULD BE MADE AT ANY ONE TIME TO THE POTENTIOMETER. MAKING SMALL ADJUSTMENTS AND RETURNING THE VEHICLE TO THE OWNER ALLOWS IT TO BE TEST DRIVEN IN A VARIETY OF SITUATIONS. IF THE VEHICLE IS RETURNED FOR A SIMILAR COMPLAINT READJUST THE POTENTIOMETER AGAIN MAKING SURE NOT TO "OVER ADJUST."

NO → CHECK FOR CODE 54 USING TECH 1 BEFORE PROCEEDING.

NO → CHECK FOR CODE 54 DIAGNOSTIC CHART FOR ADDITION INFORMATION.

"AFTER REPAIRS," START ENGINE, CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

2-8-93
NS .15202

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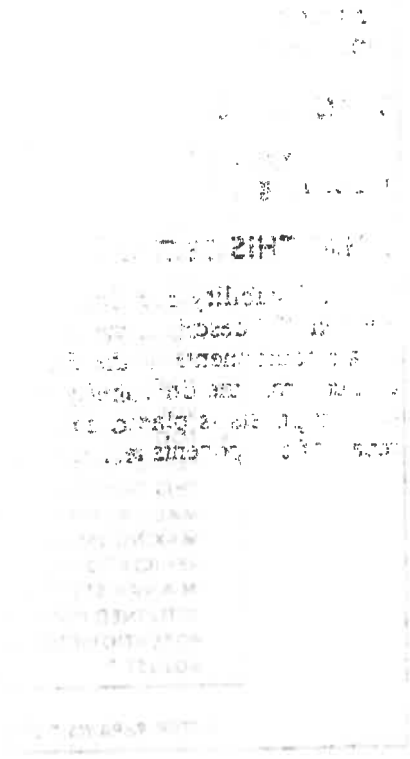


3. SERVICE OPERATIONS

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts of system damage could result.

SERVICE PRECAUTIONS

DRIVEABILITY AND EMISSIONS CONTROL

An electronic control module is designed to maintain exhaust emission levels at government standards while providing good driveability and fuel efficiency. The functions of the system are based on data gathered by sensors and switches located throughout the vehicle. The electronic control module maintains control over fuel delivery, ignition, idle air flow, the fuel pump and other system components, while monitoring the system for faulty operation with its diagnostic capabilities.

It is important to review the component sections and wiring diagrams to determine which systems are controlled by the electronic control module.

MAINTENANCE SCHEDULE

Refer to the Maintenance Schedule in the owner's handbook for the maintenance service that should be performed to retain performance.

BLOCKING DRIVE WHEELS

The vehicle drive wheels should always be blocked and parking brake firmly set while checking the system.

WHAT THIS SECTION CONTAINS

"Driveability and Emissions Service Operations," Section "3" describes the proper service procedures to repair components of the Engine Management system that controls the driveability and emissions of the vehicle. Emphasis is placed on the proper procedures and repair of components related to the system.

VISUAL/PHYSICAL UNDERHOOD INSPECTION

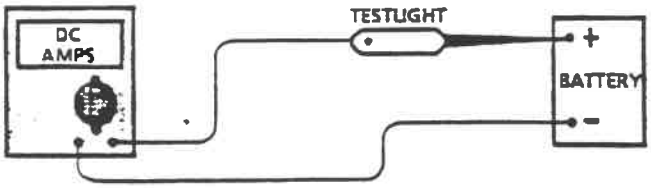
A careful visual and physical underhood inspection must be performed as part of any diagnostic procedure or in finding the cause of an emissions test failure. This can often lead to fixing a problem without further steps. Inspect all vacuum hoses for correct routing, pinches, cuts, or disconnects. Be sure to inspect hoses that are difficult to see beneath the air cleaner, compressor, alternator, etc. Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires, or contact with sharp edges or hot exhaust manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

SERVICE PRECAUTIONS

The following requirements must be observed when working on vehicles:

1. Before removing any electronic control module system component, disconnect the battery ground cable.
2. Never start the engine without the battery cables being solidly connected.
3. Never separate the battery from the on-board electrical system while the engine is running.
4. When charging the battery, disconnect it from the vehicle's electrical system.
5. Never subject the electronic control module to temperatures above 80°C i.e., paint oven. Always remove the electronic control module first if this temperature is to be exceeded.
6. Ensure that all cable harness plugs are connected solidly and that battery terminals are thoroughly clean.

7. The engine management system harness connectors are designed to fit only one way; there are indexing tabs and slots on both halves of the connector. Forcing the connector into place is not necessary if it is installed with the proper orientation. Failure to match the indexing tabs and slots on the connector can cause damage to the connector, the module, or other vehicle components or systems.
8. Never connect or disconnect the electronic control module connectors when the ignition is switched "ON."
9. Before attempting any electric arc welding on the vehicle, disconnect the battery leads and the electronic control module connectors.
10. When steam cleaning engines, do not direct the steam cleaning nozzle at electronic control module system components. If this happens, corrosion of the terminals can take place.
11. Use only the test equipment specified in the diagnostic charts, other test equipment may give incorrect results or damage good components.
12. Make all voltage measurements using a digital voltmeter with an internal impedance rating of at least 10 million ohms per volt.
13. When a test light is specified, a "low-power" test light must be used. Do not use a high wattage test light (i.e.: headlight). While a particular brand of test light is not suggested, a simple check of any test light will ensure it is safe for electronic control module circuit testing. Connect an accurate ammeter (such as the high-impedance digital multimeter) in series with the test light and power the test light-ammeter circuit with the vehicle battery.



If the ammeter indicates *less* than 1/4 amp current flow (.25 A or 250 ma), the test light is **SAFE** to use.

If the ammeter indicates *more* than 1/4 amp current flow (.25 A or 250 ma), the test light is **NOT SAFE** to use.

Electrostatic Discharge Damage

It is possible for less than 100 volts of static electricity to cause damage to some electronic components. Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge. By comparison, it takes as much as 4,000 volts for a person to even feel the zap of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a car seat where a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage; therefore, it is important to use care when handling and testing electronic components.

NOTICE: To prevent possible Electrostatic Discharge damage:

- Do Not touch the electronic control module connector pins or soldered components on the electronic control module circuit board. Never disassemble the electronic control module metal case, except for the calibrator cover.
- When handling an engine calibrator, Do Not remove integrated circuit from carrier.

REPAIR PROCEDURES

ELECTRICAL REPAIRS

This part provides instruction in the following repairs:

- Circuit Protection.
- Typical Electrical Repairs.
- Replacing terminals on unsealed components.
- Replacing pigtails on sealed components.
- Replacing connector housings on unsealed components.
- Splicing Copper Wire.
- Splicing Twisted/Shielded Cable.
- Repairing Connectors (Except Weather Pack®).
- Repairing Weather Pack® (Environmental) Autofuse Connectors.
- Terminal Repair.

After any electrical repair is made, always test the circuit by operating the devices in the circuit. This confirms not only that the repair is correct, but also, that it was the cause of the complaint.

CIRCUIT PROTECTION

The purpose of circuit protection is to protect the wiring assembly during normal and overload conditions. An overload is defined as a current requirement that is higher than normal. The overload could be caused by a short circuit or system malfunction. The short circuit could be the result of a pinched or cut wire, or an internal device short circuit, such as an electronic module failure.

The circuit protection device is only applied to protect the wiring assembly, and not the electrical load at the end of the assembly. For example, if an electronic component short circuits, the circuit protection device will assure a minimal amount of damage to the wiring assembly. However, it will not necessarily prevent damage to the component.

CIRCUIT PROTECTION DEVICES

There are two basic types of circuit protection devices: Fuse, and Fusible Link.

FUSES

The most common method of automotive wiring circuit protection is the fuse (Figure 3-1). A fuse is a device that, by the melting of its element, opens an electrical circuit when the current exceeds a given level for a sufficient time. The action is non-reversible and the fuse must be replaced each time a circuit is overloaded or after a malfunction is repaired.

Fuses are color coded. The standardized color identification and ratings are shown in Figure 3-2. For service replacement, non-color coded fuses of the same respective current rating can be used.

Examine a suspect fuse for a break in the element. If the element is broken or melted, replace the fuse with one of equal current rating.

There are additional specific circuits with in-line fuses. These fuses are located within the individual wiring harness and will appear to be an open circuit if blown.

Autofuse

The Autofuse, normally referred to simply as "Fuse," is the most common circuit protection device in today's vehicle. The Autofuse is most often used to protect the wiring assembly between the Fuse Block and the system components.

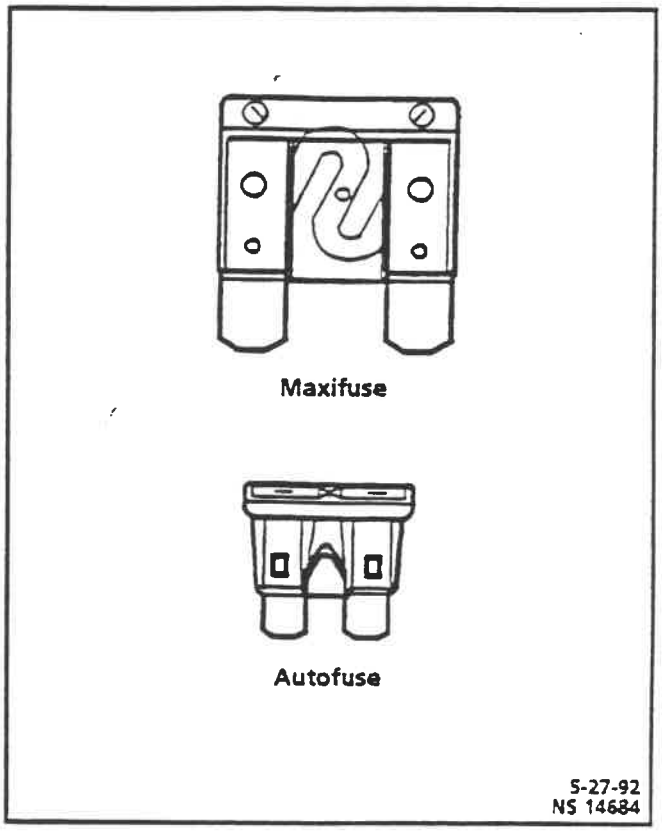


Figure 3-1 Fuse Devices

Maxifuse

The Maxifuse was designed to replace the fusible link. The Maxifuse is designed to protect cables, normally between the Battery and Fuse Block, from both direct short circuits and resistive short circuits.

Compared to a fusible link, the Maxifuse performs much more like an Autofuse, although the average opening time is slightly longer. This is because the Maxifuse was designed to be a slower blowing fuse, with less chance of nuisance blows.

Fusible Links

In addition to fuses, some circuits use fusible links to protect the wiring.

AUTOFUSE

CURRENT RATING	COLOR
3	VIOLET
5	TAN
7.5	BROWN
10	RED
15	BLUE
20	YELLOW
25	NATURAL
30	GREEN

MAXIFUSE

CURRENT RATING	COLOR
20	YELLOW
30	GREEN
40	AMBER
50	RED
60	BLUE
70	BROWN
80	NATURAL

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MS 14685

Figure 3-2 Fuse Rating and Color

Like fuses, fusible links are "one-time" protection devices that will melt and create an open circuit (see Figure 3-3).

Not all fusible link open circuits can be detected by observation. Always inspect that there is battery voltage past the fusible link to verify continuity.

Each fusible link is four wire gauges smaller than the cable it is designed to protect.

Service fusible links are available in many lengths. Choose the shortest length that is suitable. If the fusible link is to be cut from a spool, it should be cut 150-225 mm long. NEVER make a fusible link longer than 225 mm.

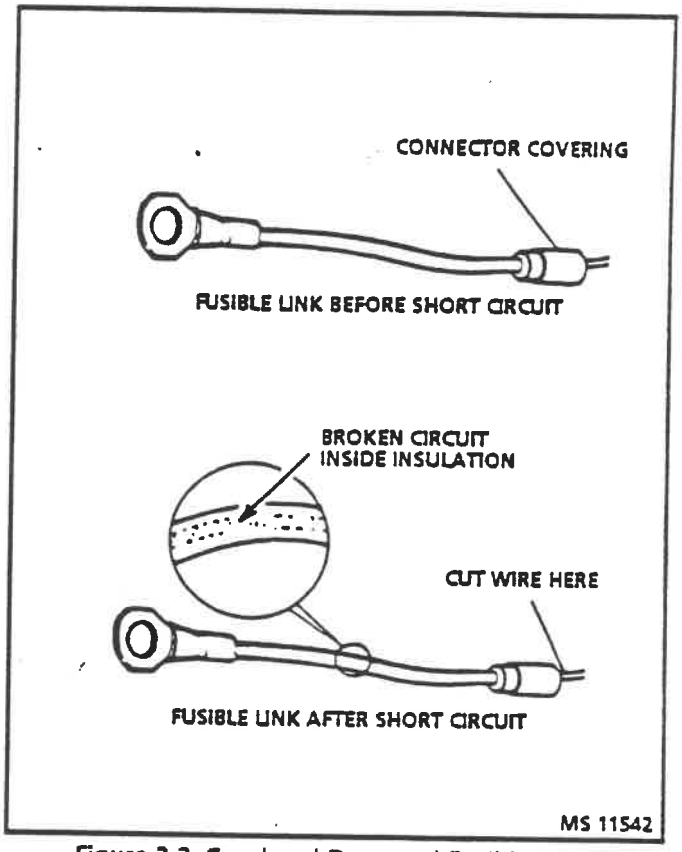

Figure 3-3 Good and Damaged Fusible Links

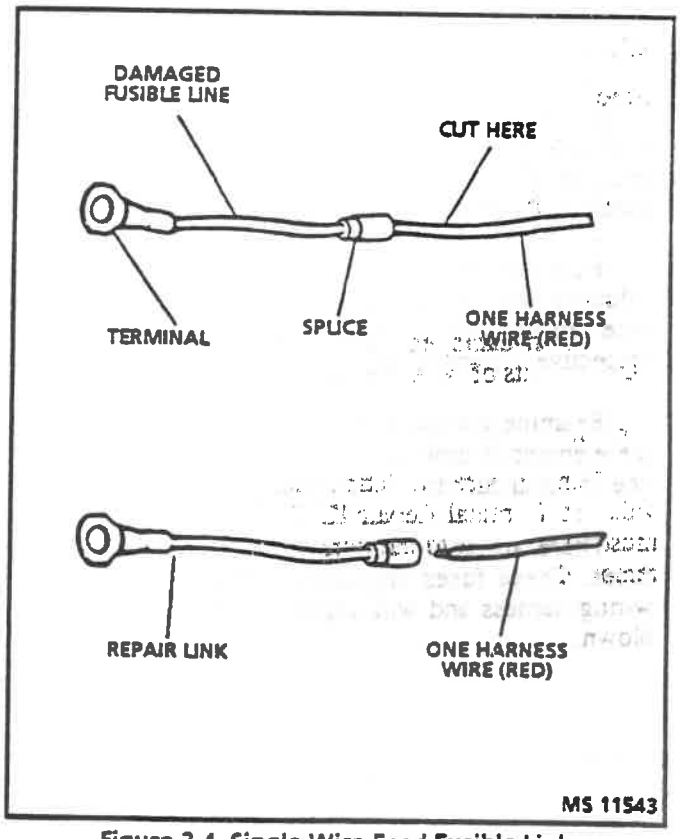

Figure 3-4 Single Wire Feed Fusible Link

CAUTION: Fusible links cut longer than 225 mm will not provide sufficient overload protection.

To replace a damaged fusible link (Figure 3-4), cut it off beyond the splice. Replace with a repair link. For splicing see "Splicing Copper Wire Using Splice Clips." To seal the splices do not use shrink tube with hot melt, there is special tubing required for fusible link applications. This special tubing is *not* included in Terminal Repair Kit J 39745. It is available, however, through Packard Electric and is referred to as "Heat Shrinking Dual Wall Tube." (ES M-2310 code 400, 500, 700.)

TYPICAL ELECTRICAL REPAIRS

An open circuit is an incomplete circuit. Power cannot reach the load or reach ground. If a circuit is open, active components do not energize. A short circuit is an unwanted connection between one part of the circuit and either ground or another part of the circuit. A short circuit causes a fuse to blow.

Short Circuits Caused By Damaged Wire Insulation

- Locate the damaged wire.
- Find and correct the cause of the wire insulation damage.

REPLACING TERMINALS ON UNSEALED COMPONENTS

Step 1:

Remove damaged terminal from the connector housing. To determine the correct removal tool to use, refer to the manual included in Terminal Repair Kit J 39745.

Step 2:

Cut off damaged terminal. Do not cut off unnecessary amounts of wire. Cut off as little as possible.

Step 3:

Remove wire insulation using the wire stripper provided in Terminal Repair Kit J 39745. Extreme caution must be used not to cut wire strands as the insulation is removed.

Step 4:

Select the correct replacement terminal (refer to Terminal Repair Kit J 39745) and position the strip in the terminal.

Step 5:

Using the correct crimp tool provided in Terminal Repair Kit J 39745, crimp the terminal. Solder all hand crimped terminals to ensure a clean, dry connection.

Step 6:

Plug the terminal into the connector housing. Be sure that the wires are plugged into the correct cavity. A properly seated terminal will "Click" when seated.

REPLACING PIGTAILS ON SEALED COMPONENTS

Pigtails are connectors with crimped wires. They are approximately 20 cm long. Pigtails are included in the Terminal Repair Kit J 39745 for all of the sealed components in the Engine Management System Wiring Harness.

Repair Procedure

Step 1:

Select the correct pigtail using the manual included in Terminal Repair Kit J 39745.

Step 2:

Cut off the damaged connector *not more than 20 cm* from the top of the connector.

Step 3:

Splice the new pigtail into the harness. To make a sealed splice see "Splicing Copper Wire Using Splice Clips, Shrink Tube and Hot Melt," included in Section 3 of this manual.

Be sure that the color of the pigtail is the same color as the wire on the wiring harness.

All pigtails are marked with a white dot so that the replaced component can be identified for service reasons.

Step 4:

If the sealed splices are not protected by conduit or tubing, wrap the splices with electrical tape to ensure a dry, clean connection.

REPLACING CONNECTOR HOUSINGS ON UNSEALED COMPONENTS

Step 1:

Remove damaged terminals from the connector housing. To determine the correct removal tool to use, refer to the manual included in Terminal Repair Kit J 39745.

Step 2:

Select the correct connector housing using the manual included in Terminal Repair Kit J 39745 as a guide.

Step 3:

Making sure that the terminals are indexed correctly, plug the terminals into the selected connector housing. Ensure that the wires are plugged into the correct cavity. A properly seated terminal will "Click" when seated.

SPLICING COPPER WIRE USING SPLICE CLIPS

Splice Clips are included in Terminal Repair Kit J 39745. The splice clip should only be used as a general purpose wire repair device.

It should only be used for applications in the passenger compartment that do not need special requirements such as moisture sealing.

Step 1: Open the Harness

If the harness is taped, remove the tape. If the harness has a black plastic conduit, simply pull out the desired wire.

Step 2: Cut the Wire

Begin by cutting as little wire off the harness as possible. You may need the extra length of the wire later if you decide to cut more wire off to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 40 mm away from an outlet(s) and 65 mm from another splice.

Step 3: Strip the Insulation

When replacing a wire, use a wire of the same size as the original wire or larger. The schematics list wire size in metric units.

If you aren't sure of the wire size, start with the largest opening in the wire stripper and work down until a clean strip of the insulation is removed. Be careful to avoid nicking or cutting any of the wires.

Step 4: Crimp the Wires

Select the proper clip to secure the splice. To determine the proper clip size for the wire being spliced, see splice crimp matrix below.

SPLICE CRIMP MATRIX

SPLICE CLIP PART NUMBER	WIRE SIZE/MM²	
	1.0-2.49	2.5-5.0
12064904	x	
12064905		x

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Figure 3-5 Splice Crimp Matrix

To select the correct crimp tool consult the instructions included in the Terminal Repair Kit J 39745. Select the correct anvil on the crimper. On most crimpers your choice is limited to either a small or large anvil. Overlap the stripped wire ends and hold them between your thumb and forefinger as shown in Figure 3-6. Then, center the splice clip under the stripped wires and hold it in place.

- Open the crimping tool to its full width and rest one handle on a firm flat surface.
- Center the back of the splice clip on the proper anvil and close the crimping tool to the point where the former touches the wings of the clip.
- Make sure that the clip and wires are still in the correct position. Then, apply steady pressure until the crimping tool closes.

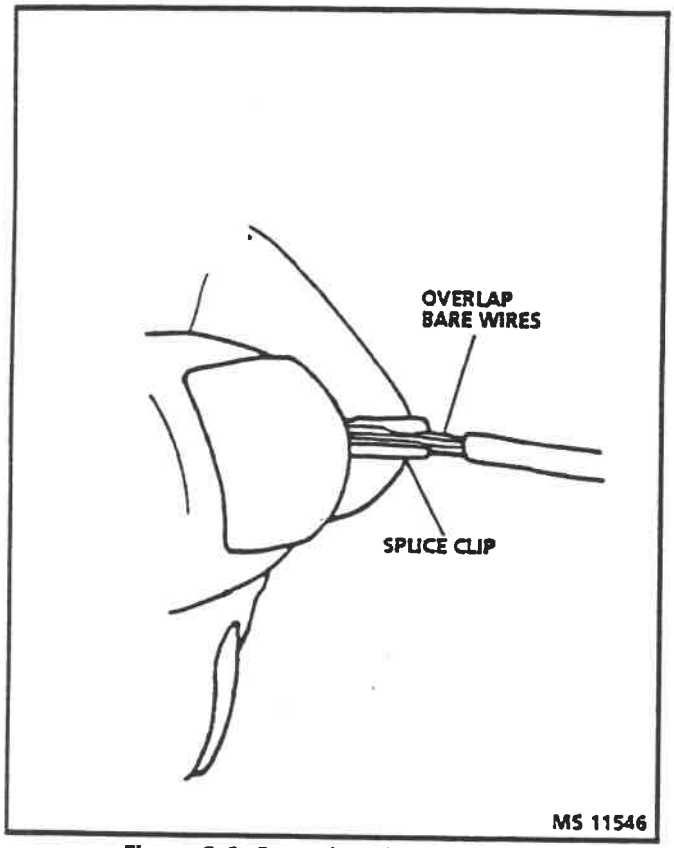


Figure 3-6 Centering the Splice Clip

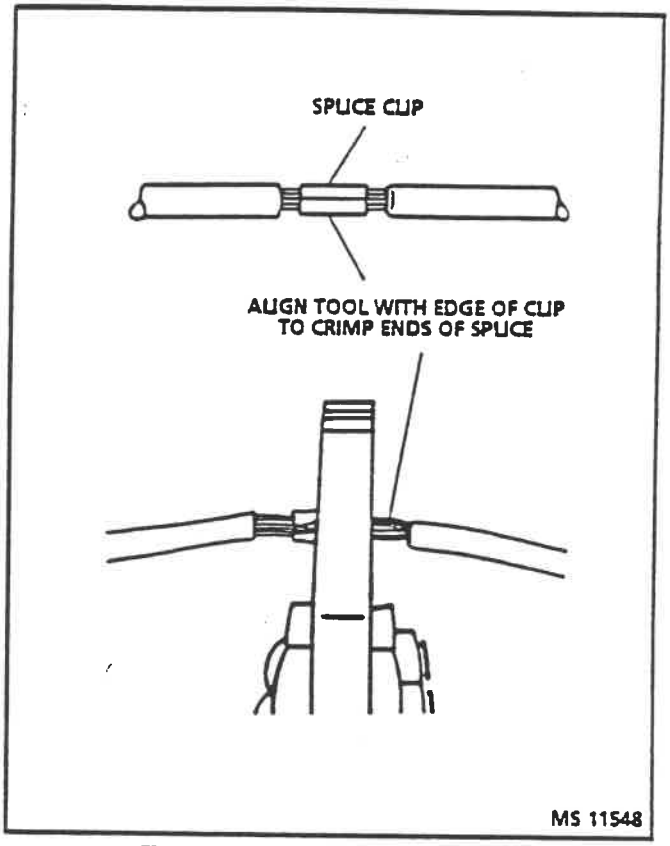


Figure 3-8 Completing the Crimp

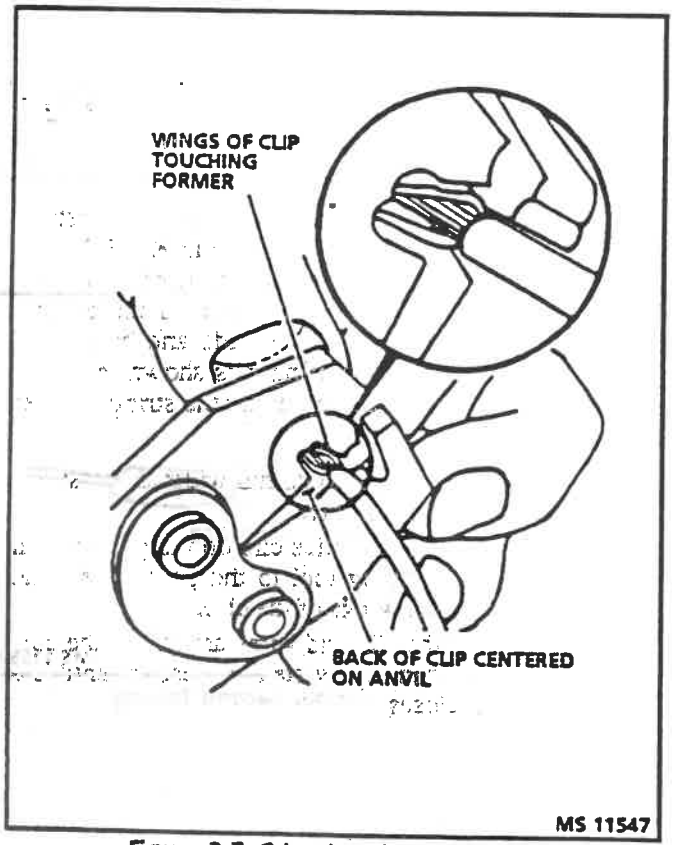


Figure 3-7 Crimping the Splice Clip

- Before crimping the ends of the clip, be sure that:
  - The wires extend beyond the clip in each direction.
  - No strands of wire are cut loose, and
  - No insulation is caught under the clip.

Crimp the splice again, once on each end. Do not let the crimping tool extend beyond the edge of the clip or you may damage or nick the wires (Figure 3-8).

Step 5: Solder

Apply 60/40 rosin core solder to the opening in the back of the clip (see Figure 3-9). Follow the manufacturer's instruction for the solder equipment you are using.

Step 6: Tape the Cable

Center and roll the splicing tape. The tape should cover the entire splice. Roll on enough tape to duplicate the thickness of the insulation on the existing wires. Do not flag the tape. Flagged tape may not provide enough insulation, and the flagged ends will tangle with the other wires in the harness (see Figure 3-10).

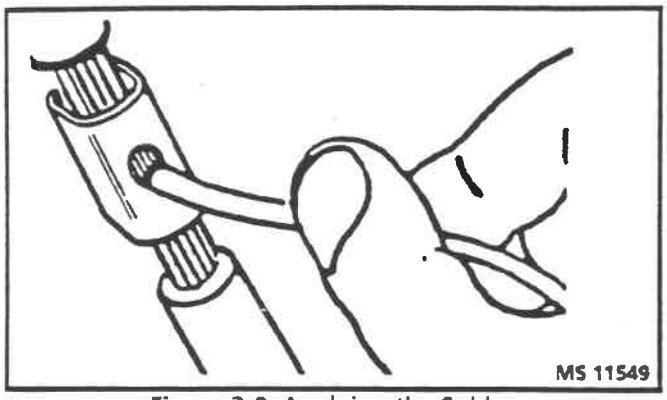


Figure 3-9 Applying the Solder

If the wire does not belong in a conduit or other harness covering, tape the wire again. Use a winding motion to cover the first piece of tape (Figure 3-11).

SPLICING COPPER WIRE USING SPLICE CLIP, SHRINK TUBE AND HOT MELT

For applications in the engine compartment it is necessary to have sealed splices because of the potential of moisture invading the splice. Splice clips, shrink tube and hot melt are included in Terminal Repair Kit J 39745.

Step 1: Open the Harness

If the harness is taped, remove the tape. If the harness has a block plastic conduit, simply pull out the wire.

Step 2: Cut the Wire

Begin by cutting as little wire off the harness as possible. You may need the extra length of wire later if you decide to cut more wire to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 40 mm away from an outlet(s) and 65 mm away from other splices.

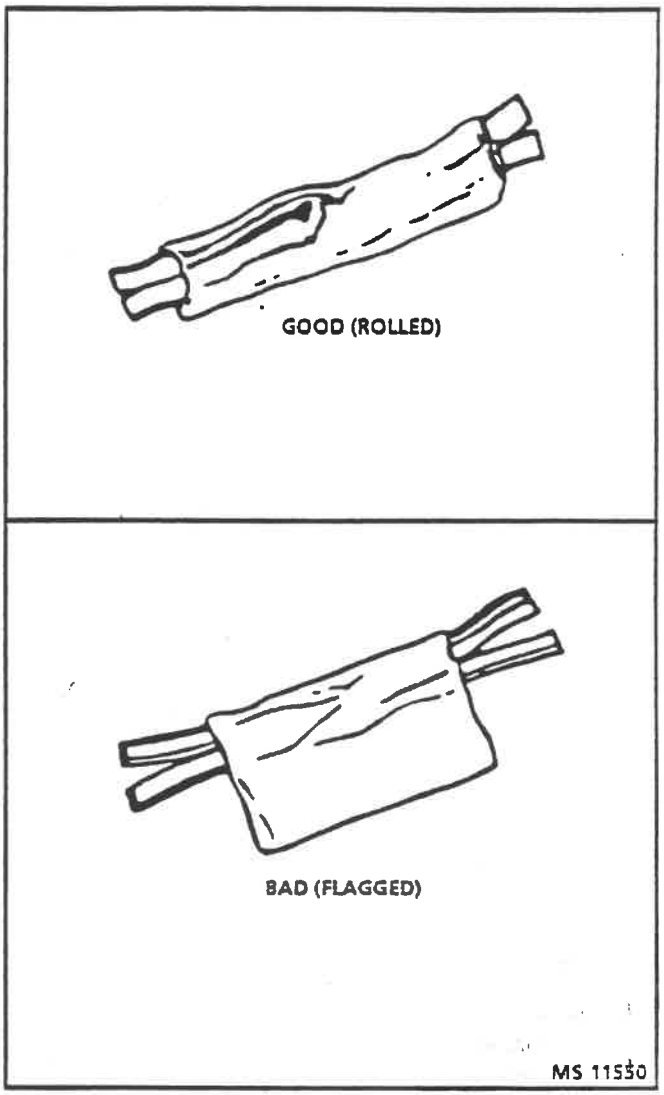


Figure 3-10 Proper First Taping

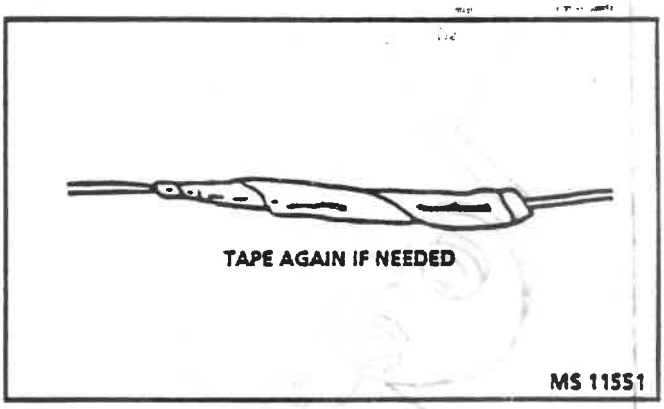


Figure 3-11 Proper Second Taping

This will help prevent moisture from bridging adjacent splices and causing damage.

Step 3: Strip the Insulation

When replacing a wire, use a wire of the same size as the original wire or larger. The schematics list wire size in metric units.

If you aren't sure of the wire size, start with the largest opening in the wire stripper and work down until a clean strip of the insulation is removed. Be careful to avoid nicking or cutting any of the wires.

Step 4: Crimp the Wires

Remove the appropriate size shrink tube from Terminal Repair Kit J 39745 and slip it over the end of the wire. Select the proper clip to secure the splice. To determine the proper clip size for the wire being spliced, see splice crimp matrix below.

SPLICE CRIMP MATRIX

SPLICE CLIP PART NUMBER	WIRE SIZE/MM²	
	1.0-2.49	2.5-5.0
12064904	x	
12064905		x

4-27-93
NS 15697

Figure 3-12 Splice Crimp Matrix

To select the correct crimp tool consult the instructions included in the Terminal repair kit J 39745. Select the correct anvil on the crimper. On most crimpers your choice is limited to either a small or large anvil. Overlap the stripped wire ends and hold them between your thumb and forefinger as shown in Figure 3-6. Then, center the splice clip under the stripped wires and hold it in place.

- Open the crimping tool to its full width and rest one handle on a firm flat surface.
- Center the back of the splice clip on the proper anvil and close the crimping tool to the point where the former touches the wings of the clip.
- Make sure that the clip and wires are still in the correct position. Then, apply steady pressure until the crimping tool closes.
- Before crimping the ends of the clip, be sure that:
  - The wires extend beyond the clip in each direction.
  - No strands of wire are cut loose, and
  - No insulation is caught under the clip.

Crimp the splice again, once on each end. Do not let the crimping tool extend beyond the edge of the clip or you may damage or nick the wires (Figure 3-8).

Step 5: Solder

Apply 60/40 rosin core solder to the opening in the back of the clip (see Figure 3-9). Follow the manufacturer's instruction for the solder equipment you are using.

Step 6: Shrink Tube/Hot Melt

Shrink tube should now be applied to ensure that the splice remains clean and dry. Position the proper size shrink tube so that the splice clip and any bare copper wire is covered. Lay several pieces of hot melt under the shrink tube as close as possible to the middle of the splice. Shrink tube and hot melt are available in Terminal Repair Kit J 39745.

Step 7: Apply Heat

Using an appropriate low heat source, apply heat to the shrink tube. Be extremely careful not to position the heat source too close to the shrink tube, it will melt if overexposed to heat.

After a few seconds of moderate heat the shrink tube will melt and a small amount of hot melt will come out the end of the tube. The shrink tube will conform to the splice providing a clean, dry seal.

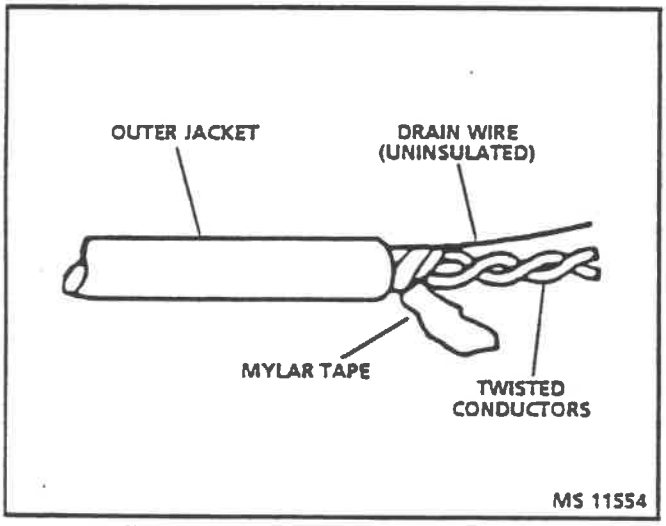


Figure 3-13 Twisted/Shielded Cable

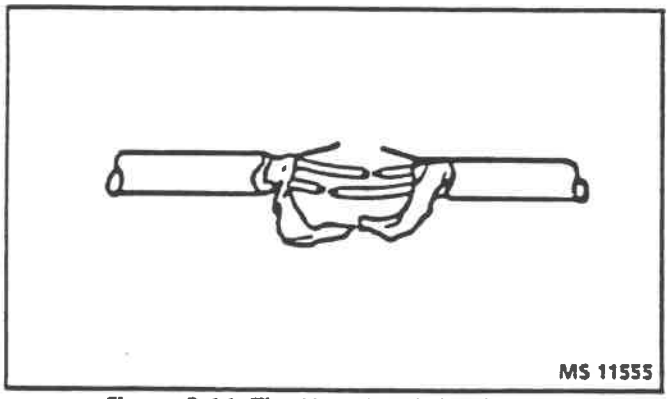


Figure 3-14 The Untwisted Conductors

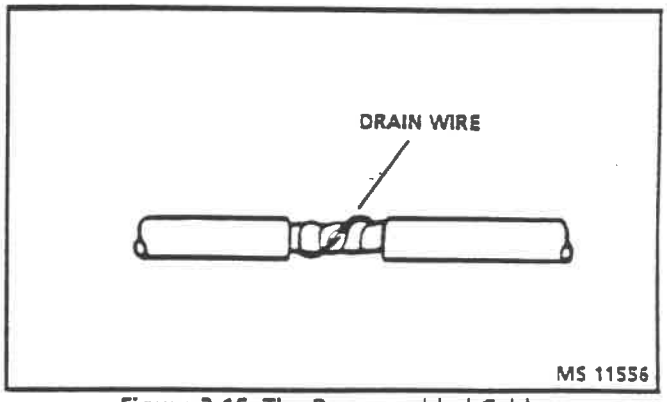


Figure 3-15 The Re-assembled Cable

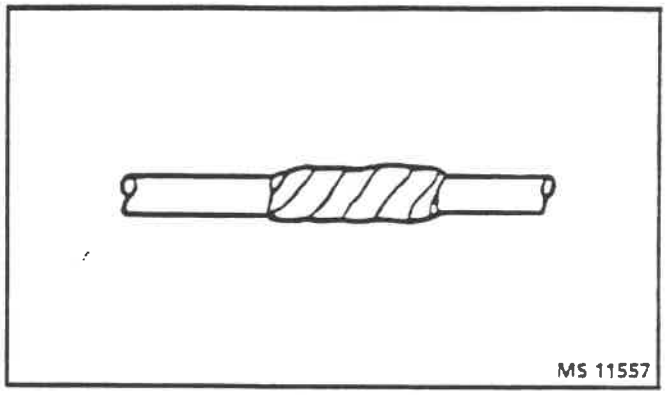


Figure 3-16 Proper Taping

SPLICING TWISTED/SHIELDED CABLE

Twisted/shielded cable is sometimes used to protect wiring from electrical noise (stray signals). For example, two-conductor cable of this construction is used between the electronic control module and the ignition module. See Figure 3-13 for a breakdown of twisted/shielded cable construction.

Step 1: Remove Outer Jacket

Remove the outer jacket and discard it. Be careful to avoid cutting into the drain wire or the mylar tape.

Step 2: Unwrap the Tape

Unwrap the aluminum/mylar tape, but do not remove it. The tape will be used to rewrap the twisted conductors after the splices have been made.

Step 3: Prepare the Splice

Untwist the conductors. Then, prepare the splice by following the splicing instructions for copper wire presented earlier. Remember to stagger splices to avoid shorts (Figure 3-14).

Step 4: Re-assemble the Cable

After you have spliced and taped each wire, rewrap the conductors with the mylar tape. Be careful to avoid wrapping the drain wire in the tape.

Next, splice the drain wire following the splicing instructions for copper wire. Then, wrap the drain wire around the conductors and mylar tape (Figure 3-15).

Step 5: Tape the Cable

Tape over the entire cable using a winding motion (see Figure 3-16). This tape will replace the section of the jacket you removed to make the repair.

REPAIRING CONNECTORS

- The following general repair procedures can be used to repair most types of connectors. The repair procedures are divided into three general groups: Push-to-Seat and Pull-to-Seat and Weather Pack®.
- See "Terminal Repair Kit Instruction Manual," (J 39745) to determine which type of connector is to be serviced.
- Use the proper Pick(s) or Tool(s) that apply to the terminal.

PUSH-TO-SEAT AND PULL-TO-SEAT

Follow the steps below to repair Push-to-Seat (Figure 3-17) or Pull-to-Seat (Figure 3-18) connectors. The steps are illustrated with typical connectors. Your connector may differ, but the repair steps are similar. Some connectors do not require all the steps shown. Skip those that don't apply.

Step 1: Remove any connector position assurance locks. Connector position assurances are designed to retain connectors when mated.

Step 2: Remove any terminal position assurance Locks. Terminal position assurances are designed to keep the terminal from backing out of the connector.

NOTICE: The terminal position assurance must be removed prior to terminal removal and must be replaced when the terminal is repaired and reseated.

Step 3: Open any secondary locks. A secondary lock aids in terminal retention and is usually molded to the connector.

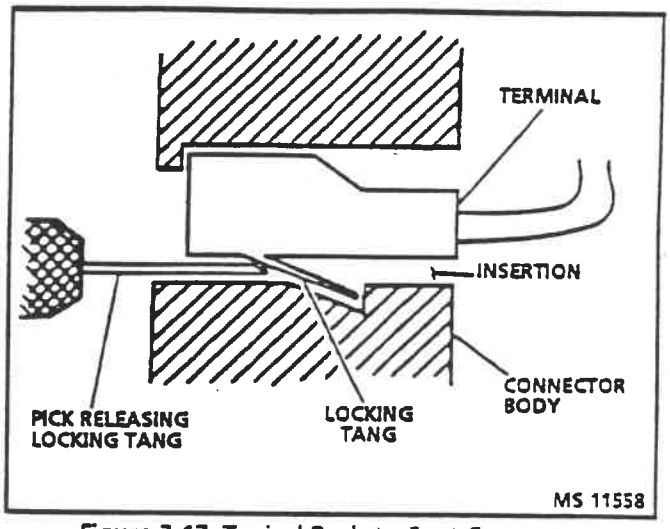


Figure 3-17 Typical Push-to-Seat Connector and Terminal

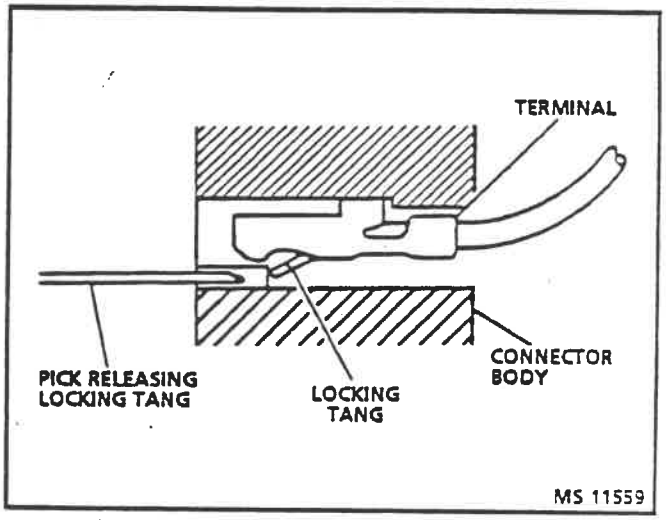


Figure 3-18 Typical Pull-to-Seat Connector and Terminal

Step 4: Separate the connector halves and back out seals.

Step 5: Grasp the lead and push the terminal to the forward most position. Hold the lead at this position.

Step 6: Locate the terminal lock tang in the connector canal.

Step 7: Insert the proper size pick (refer to Terminal Repair Kit J 39745) straight into the connector canal at the mating end of the connector.

Step 8: Depress the locking tang to unseat the terminal.

Push-to-Seat - Gently pull on the lead to remove the terminal through the back of the connector.

Pull-to-Seat - Gently push on the lead to remove the terminal through the front of the connector.

NOTICE: Never use force to remove a terminal from a connector.

Step 9: Inspect terminal and connector for damage. Repair as necessary.

Step 10: Reform lock tang and reseat terminal in connector body. Apply grease if connector was originally equipped with grease.

Step 11: Install any connector position assurances or terminal position assurances, close any secondary locks and join connector halves.

WEATHER PACK

Follow the steps below to repair Weather Pack® connectors (Figure 3-19).

Step 1: Separate the connector halves.

Step 2: Open secondary lock. A secondary lock aids in terminal retention and is usually molded to the connector.

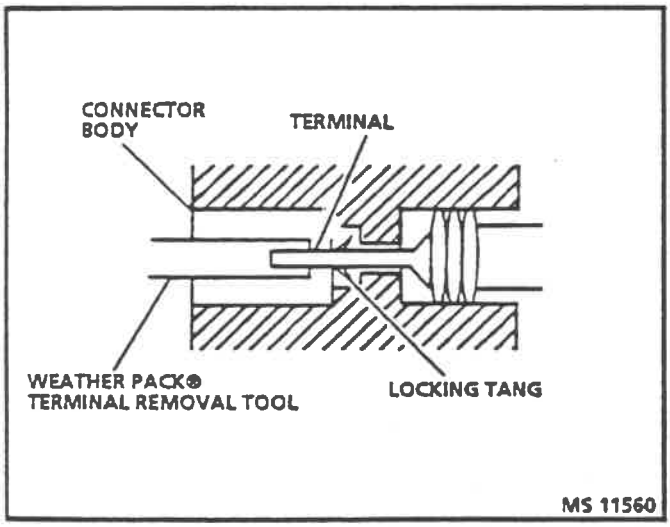


Figure 3-19 Typical Weather Pack® Connector and Terminal

Step 3: Grasp the lead and push the terminal to the forward most position. Hold the lead at this position.

Step 4: Insert the Weather Pack® terminal removal tool into the front (mating end) of the connector cavity until it rests on the cavity shoulder.

Step 5: Gently pull on the lead to remove the terminal through the back of the connector.

NOTICE: Never use force to remove a terminal from a connector.

Step 6: Inspect the terminal and connector for damage. Repair as necessary (see "Terminal Repair," on following page).

Step 7: Reform the lock tang and reseat terminal in connector body.

Step 8: Close secondary locks and join connector halves.

TERMINAL REPAIR

The following repair procedures can be used to repair Push-to-Seat, Pull-to-Seat or Weather Pack® terminals (Figure 3-20). Some terminals do not require all steps shown. Skip those that don't apply. The Terminal Repair Kit (J 39745) contains additional information.

Step 1: Cut off terminal between core and insulation crimp (minimize wire loss) and remove seal for Weather Pack® terminals.

Step 2: Apply correct seal per gauge size of wire and slide back along wire to enable insulation removal (Weather Pack® terminals only).

Step 3: Remove insulation.

Step 4: Align seal with end of cable insulation (Weather Pack® terminals only).

Step 5: Position strip (and seal for Weather Pack®) in terminal.

Step 6: Hand crimp core wings.

Step 7: Hand crimp insulation wings (non-Weather Pack®). Hand crimp insulation wings around seal and cable (Weather Pack®).

Step 8: Solder all hand crimped terminals.

WIRING CONNECTOR SERVICE

Most connectors in the engine compartment are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may locate the open circuit condition.

This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Weather-Pack and Compact Three connectors look similar but are serviced differently.

Metri-Pack Series 150 Terminals

Some electronic control module harness connectors contain terminals called Metri-Pack (see Figure 3-21). These are used at the coolant temperature sensor.

Metri-Pack terminals are also called "Pull-to-Seat" terminals because to install a terminal on a wire, the wire is first inserted through the seal and connector. The terminal is then crimped on the wire, and the terminal pulled back into the connector to seat it in place.

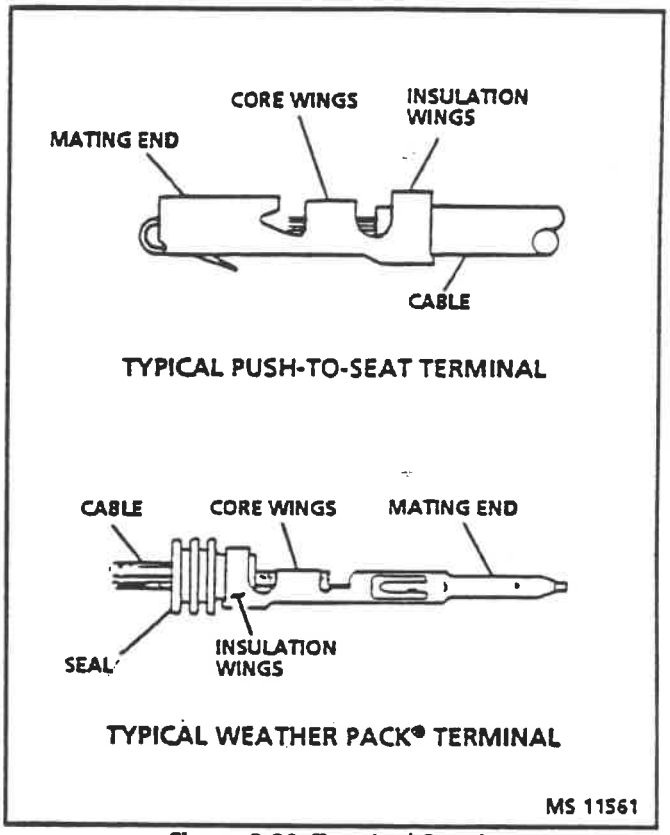


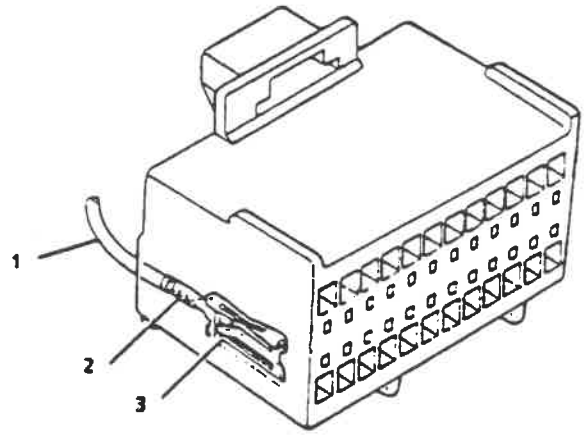
Figure 3-20 Terminal Repair

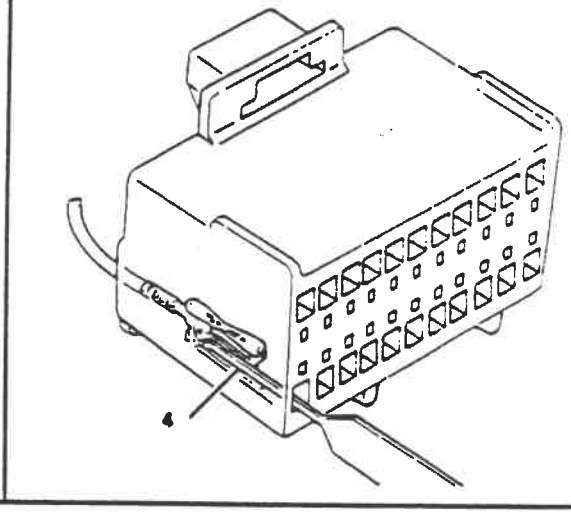
To remove a terminal:

1. Slide the seal back on the wire.
2. Insert tool as shown in Figure 3-21 insert "A", to release the terminal locking tang.

Weather-Pack Connectors

Figure 3-22 shows a Weather-Pack connector and the tool required to service it. This tool is used to remove the pin and sleeve terminals. If terminal removal is attempted with an ordinary pick, there is a good chance that the terminal will be bent or deformed, and unlike standard blade type terminals, these terminals cannot be straightened once they are bent.



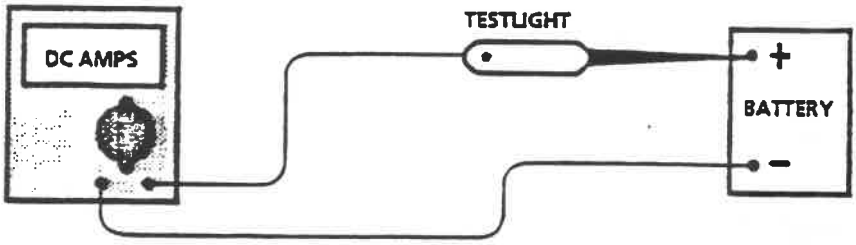


1 CABLE	3 LOCKING TANG
2 TERMINAL	4 TOOL J 38125-12

1. GRASP CABLE AND PUSH TERMINAL TO THE MOST FORWARD POSITION.
2. INSERT TOOL J 38125-12 STRAIGHT INTO THE FRONT OF THE CONNECTOR CAVITY. DO NOT USE CONVENTIONAL PICK TO REMOVE TERMINAL.
3. WITH TOOL IN PLACE, GENTLY PULL ON THE CABLE TO REMOVE TERMINAL.
4. VISUALLY CHECK TERMINAL AND REPLACE IF TERMINAL CAVITY OR TANG IS DAMAGED.
5. INSTALL TERMINAL INTO CONNECTOR CAVITY UNTIL LOCKING TANG HAS SNAPPED INTO POSITION.

MS 10016-6E

Figure 3-23 Micro-Pack Terminal Replacement



If the ammeter indicates ***less*** than 1/4 amp current flow (.25a or 250 ma), the testlight is ***safe*** to use.

If the ammeter indicates ***more*** than 1/4 amp current flow (.25a or 250 ma), the testlight is ***not safe*** to use.

5-27-92
NS 14681

Figure 3-24 Test Light Check

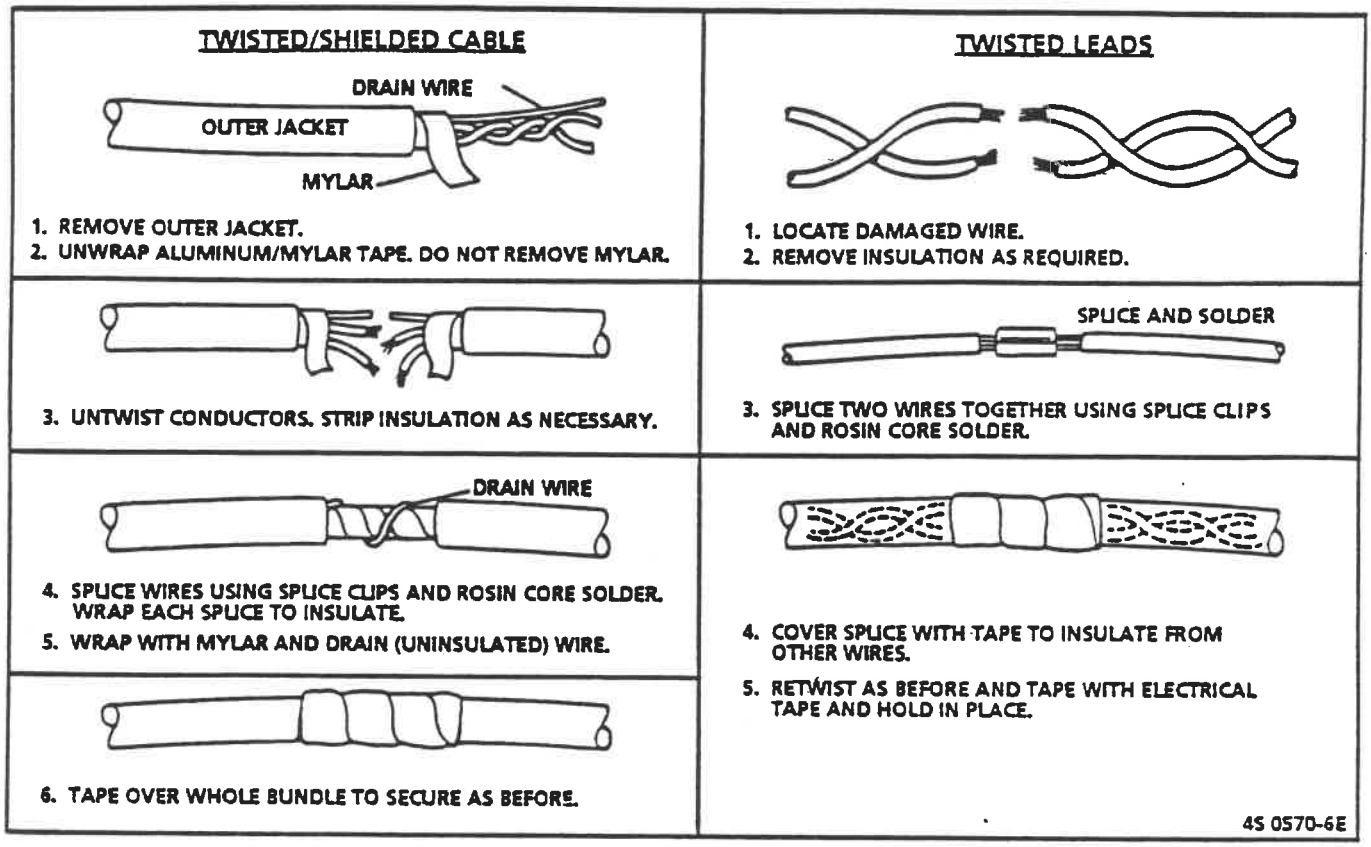

TWISTED/SHIELDED CABLE
DRAIN WIRE
OUTER JACKET
MYLAR
1. REMOVE OUTER JACKET.
2. UNWRAP ALUMINUM/MYLAR TAPE. DO NOT REMOVE MYLAR.
3. UNTWIST CONDUCTORS. STRIP INSULATION AS NECESSARY.
DRAIN WIRE
4. SPLICE WIRES USING SPLICE CLIPS AND ROSIN CORE SOLDER. WRAP EACH SPLICE TO INSULATE.
5. WRAP WITH MYLAR AND DRAIN (UNINSULATED) WIRE.
6. TAPE OVER WHOLE BUNDLE TO SECURE AS BEFORE.
TWISTED LEADS
1. LOCATE DAMAGED WIRE.
2. REMOVE INSULATION AS REQUIRED.
SPLICE AND SOLDER
3. SPLICE TWO WIRES TOGETHER USING SPLICE CLIPS AND ROSIN CORE SOLDER.
4. COVER SPLICE WITH TAPE TO INSULATE FROM OTHER WIRES.
5. RETWIST AS BEFORE AND TAPE WITH ELECTRICAL TAPE AND HOLD IN PLACE.
4S 0570-6E

Figure 3-25 Wiring Harness Repair

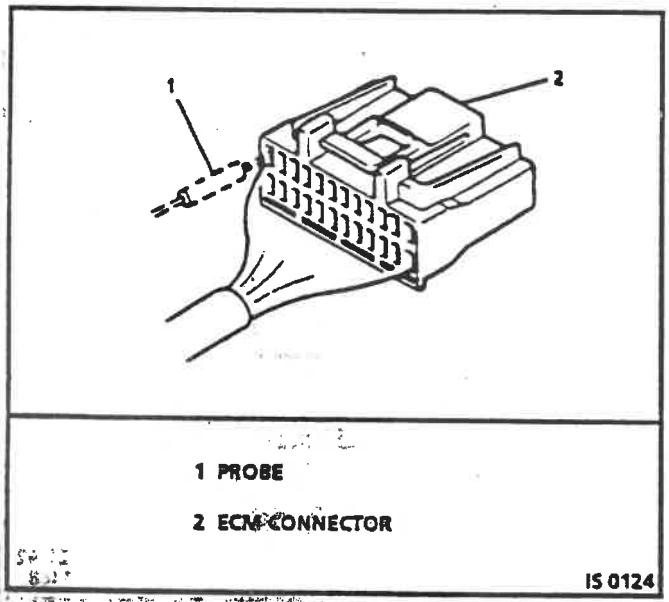


Figure 3-26 Electronic Control Module Terminal Probe Technique

3.1 ELECTRONIC CONTROL MODULE AND SENSORS

ELECTRONIC CONTROL MODULE

If the diagnostic procedures call for the electronic control module to be replaced, the engine calibrator and electronic control module should be checked first to see if they are the correct parts. If they are, remove the engine calibrator from the faulty electronic control module and install it in the new service electronic control module. THE SERVICE electronic control module WILL NOT CONTAIN AN engine calibrator. Code 61 indicates the engine calibrator is installed improperly or has malfunctioned. When Code 51 is obtained, check the engine calibrator installation for bent pins or pins not fully seated in the socket. If the engine calibrator is installed correctly and Code 51 still shows, replace the engine calibrator.

LOCATION: Driver's side of vehicle, behind kick panel.

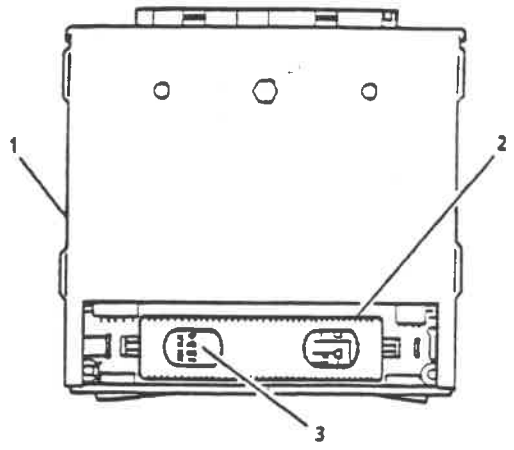
Important

- When replacing the production electronic control module with a service electronic control module, it is important to transfer the calibrator identification and production electronic control module number to the service electronic control module label (see Figure 3.1-1). Please do not record on electronic control module cover. This will allow positive identification of electronic control module parts throughout the service life of the vehicle.

  NOTICE: To prevent internal electronic control module damage, the ignition must be "OFF" when disconnecting or reconnecting power to electronic control module (for example, battery cable, electronic control module pigtail, electronic control module fuse, jumper cables, etc.).

Remove or Disconnect

1. Negative battery cable.
2. Driver's kick panel.
3. Electronic control module from bracket and connectors. (See Figure 3.1-2.)
4. Engine calibrator access cover. (See Figure 3.1-3.)
5. Engine calibrator from electronic control module.



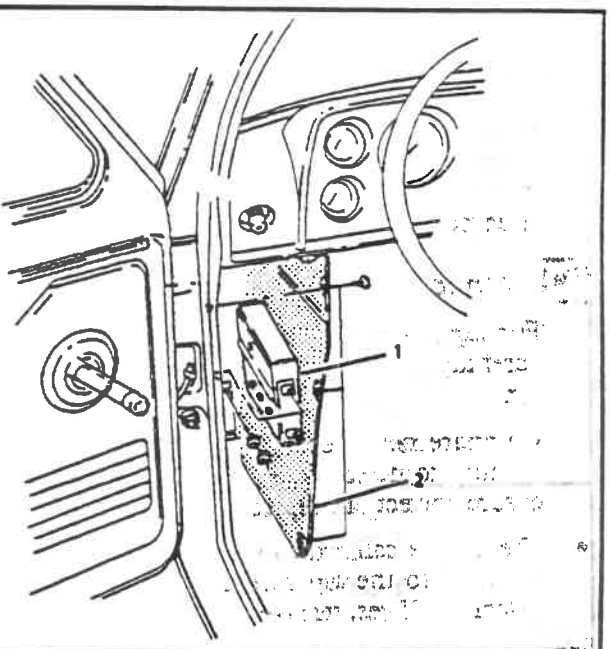
1 ELECTRONIC CONTROL MODULE

2 CALIBRATOR

3 CALIBRATOR IDENTIFICATION

NS 14510

Figure 3.1-1 Calibrator Identification



1 ELECTRONIC CONTROL MODULE

2 KICK PANEL

NS 13182

Figure 3.1-2 Electronic Control Module Location View

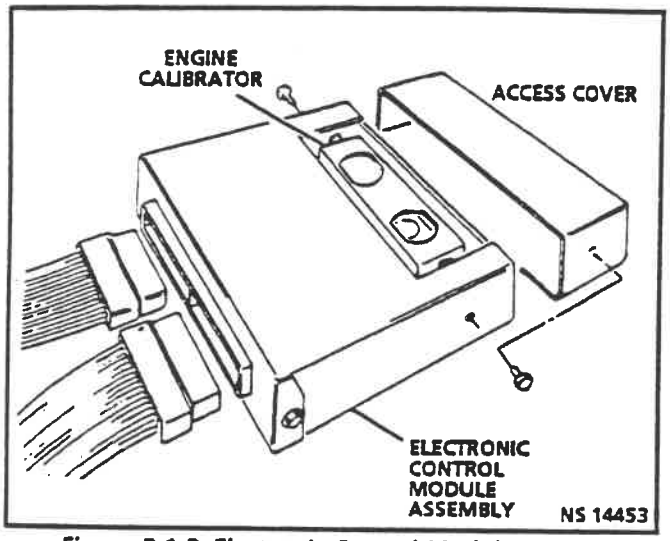


Figure 3.1-3 Electronic Control Module Engine Calibrator Access Cover

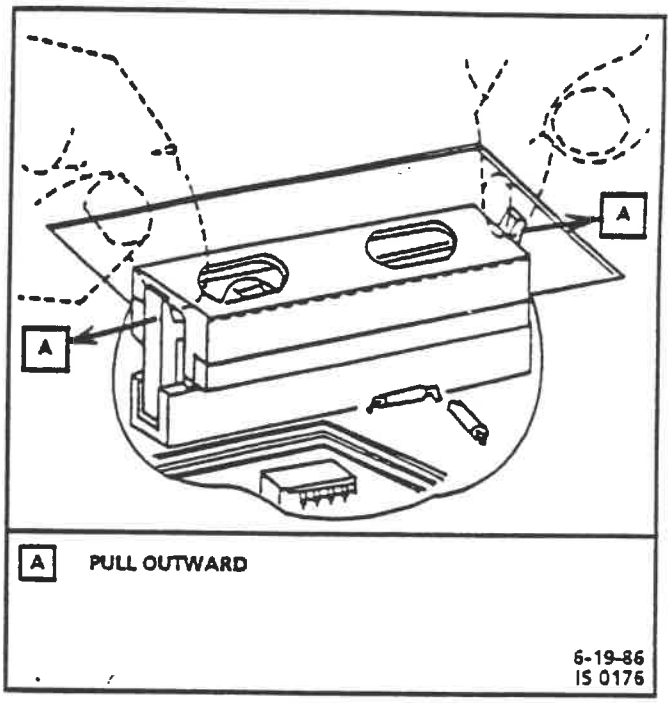


Figure 3.1-4 Engine Calibrator Removal

Important

- Replacement electronic control module is supplied without a memory-calibration unit (engine calibrator) so care should be taken when removing the engine calibrator (See Figure 3.1-4) from the defective electronic control module as it will be reused in the new electronic control module.
- Using two fingers, push both retaining clips back away from the engine calibrator at the same time (See Figure 3.1-4). Grasp the engine calibrator at both ends and lift up out of the engine calibrator socket. Do not remove the cover of the engine calibrator. Use of unapproved engine calibrator removal methods will cause damage to the engine calibrator or engine calibrator socket.

Inspect

- For alignment notches of the engine calibrator and carefully set aside. Do not open the engine calibrator.
- Compare new electronic control module service number to defective electronic control module to ensure correct part replacement.
- The engine calibrator to determine if a cork spacer is glued to the top side of the engine calibrator assembly. If yes, remove it prior to installation.

Install or Connect

1. Old engine calibrator in new electronic control module.

Important

- Align the small notches with matching notches in the electronic control module's engine calibrator socket.

  VERY GENTLY press down on the ends of the engine calibrator until the locking levers are rotated toward the sides of the engine calibrator. (Figure 3.1-5.)

NOTICE: To avoid electronic control module damage, DO NOT press on the ends of the engine calibrator until the levers snap into place. DO NOT use any vertical force beyond the minimum required to engage the engine calibrator into its socket.

  While continuing light pressure on the ends of the engine calibrator, use your index fingers to press the locking levers inward until they are snapped into place. Listen for the click.

2. Engine calibrator cover.
3. Electronic control module into vehicle.
4. Connectors.
5. Driver's kick panel.
6. Negative battery cable.

ENGINE CALIBRATOR

Code 51 indicates a faulty engine calibrator, bent pins, or incorrect installation.

Important

- The engine calibrator is "keyed" to prohibit improper insertion. However, it is essential that the correct engine calibrator be used with a specific model.

NOTICE: The ignition should always be "OFF" when installing or removing the electronic control module connectors.

LOCATION: Under access cover of electronic control module. (Figure 3.1-3).

Remove or Disconnect

1. Negative battery cable.
2. Driver's kick panel.
3. Electronic control module mounting hardware.
4. Connectors from electronic control module.
5. Electronic control module from passenger compartment.
6. Electronic control module access cover.
7. Remove engine calibrator assembly. (Figure 3.1-4).

Inspect

- The engine calibrator to determine if a cork spacer is glued to the top side of the engine calibrator assembly. If yes, remove it prior to installation.

Install or Connect

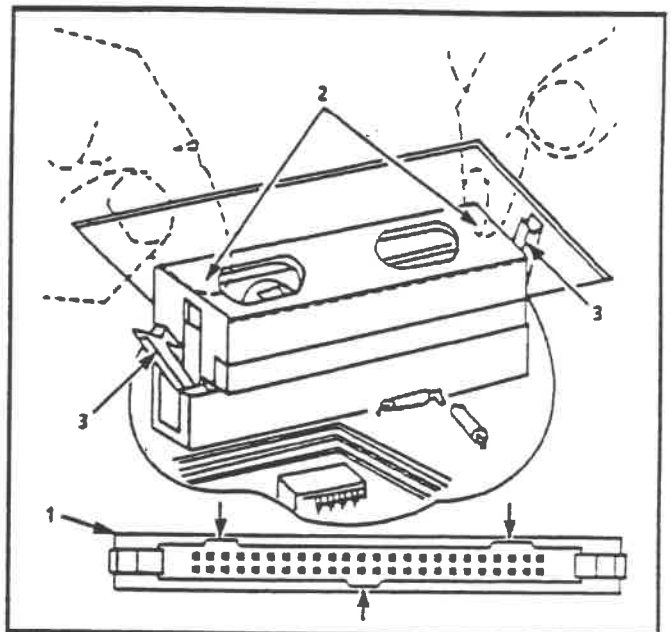
1. Old engine calibrator in new electronic control module.

Important

- Align the small notches with matching notches in the electronic control module's engine calibrator socket.

VERY GENTLY press down on the ends of the engine calibrator until the locking levers are rotated toward the sides of the engine calibrator. (Figure 3.1-5).

NOTICE: To avoid electronic control module damage, DO NOT press on the ends of the engine calibrator until the levers snap into place. DO NOT use any vertical force beyond the minimum required to engage the engine calibrator into its socket.



1 PLACE ENGINE CALIBRATOR IN CALIBRATOR SOCKET

2 PUSH DOWN GENTLY

3 PUSH INWARD UNTIL LATCHES ARE SECURE

NS 14425

Figure 3.1-5 Engine Calibrator Installation

While continuing light pressure on the ends of the engine calibrator, use your index fingers to press the locking levers inward until they are snapped into place. Listen for the click.

2. Engine calibrator cover.
3. Electronic control module into vehicle.
4. Connectors.
5. Driver's kick panel.
6. Negative battery cable.

FUNCTIONAL CHECK

1. Turn ignition "ON."
2. Enter diagnostics (see diagnostic circuit check for procedure).
   A. Code 12 should flash at least four times. (No other codes present). This indicates the engine calibrator is installed properly.
   B. If Code 51 occurs or if the "Check Engine" light is "ON" constantly with no codes, the engine calibrator is not fully seated, has bent pins, or is defective.
      - If not fully seated, press firmly on engine calibrator assembly (Figure 3.1-5).
      - If pins bend, remove engine calibrator, straighten pins, and reinstall.

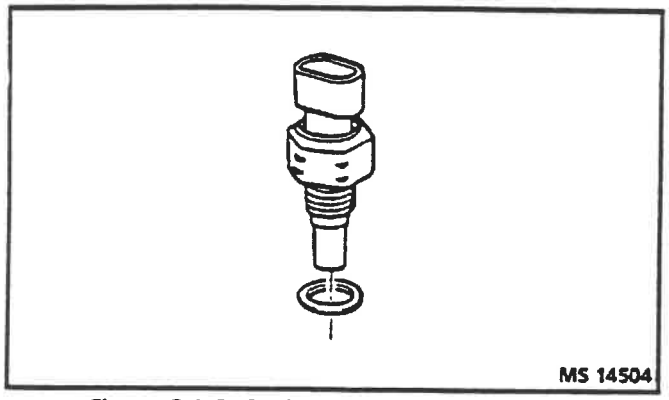


Figure 3.1-6 Coolant Temperature Sensor

COOLANT TEMPERATURE SENSOR
Figures 3.1-6 and 3.1-7

Important

- Care must be taken when handling coolant sensor. Damage to coolant sensor will affect proper operation of the Fuel Injection system.

Remove or Disconnect

1. Ignition "OFF."
2. Electrical connector.
3. Carefully back out coolant temperature sensor.

Install or Connect

1. Sensor in engine.
2. Electrical connector.

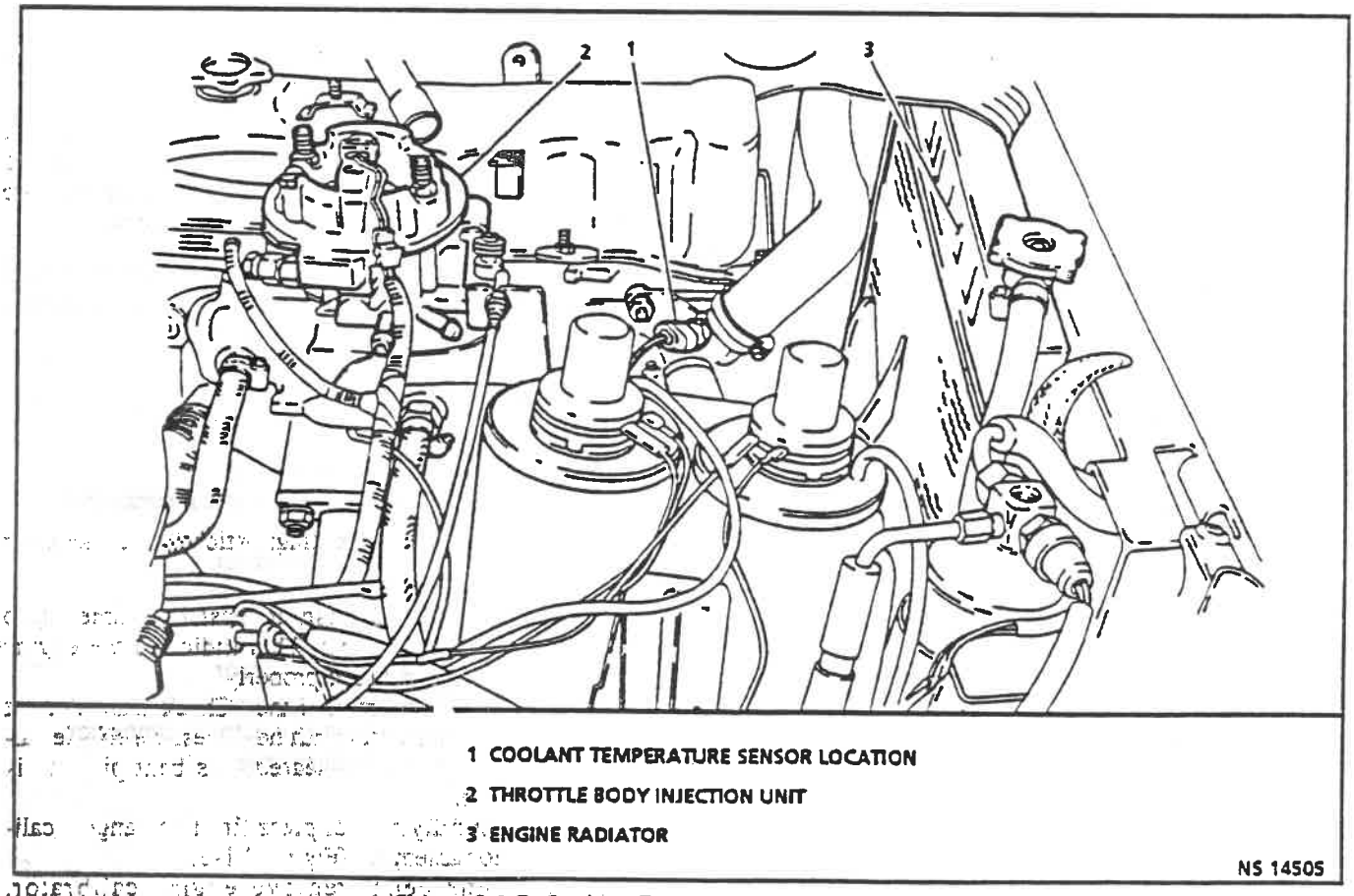


Figure 3.1-7 Coolant Temperature Sensor Location

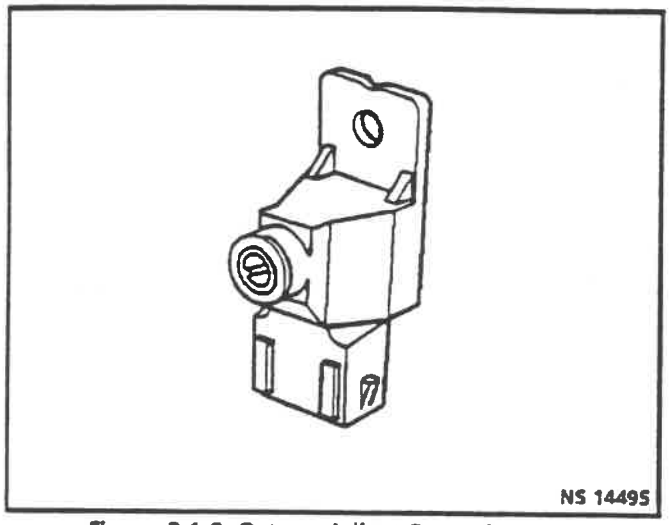


Figure 3.1-8 Octane Adjust Potentiometer

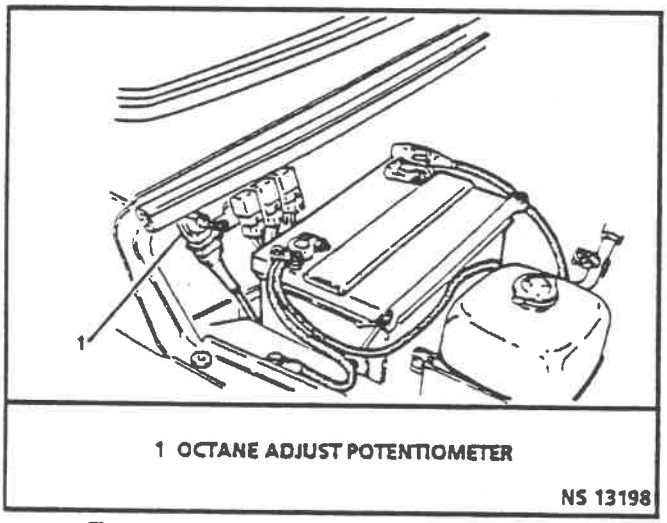


Figure 3.1-9 Octane Adjust Potentiometer Location View.

OCTANE ADJUSTMENT POTENTIOMETER
Figures 3.1-8 and 3.1-9

Remove or Disconnect

1. Electrical connector.
2. Mounting screw(s).
3. Octane adjustment potentiometer.

Install or Connect

1. Octane adjustment potentiometer.
2. Mounting screw(s).
3. Electrical connector.
4. The octane adjust potentiometer is preset at the factory at 0° of retard. If an adjustment is needed, refer to CHART C-15.

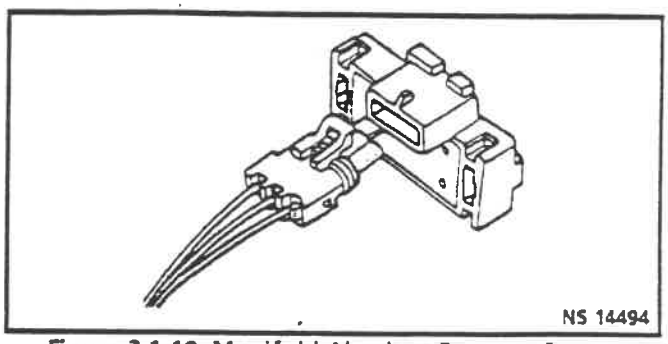


Figure 3.1-10 Manifold Absolute Pressure Sensor

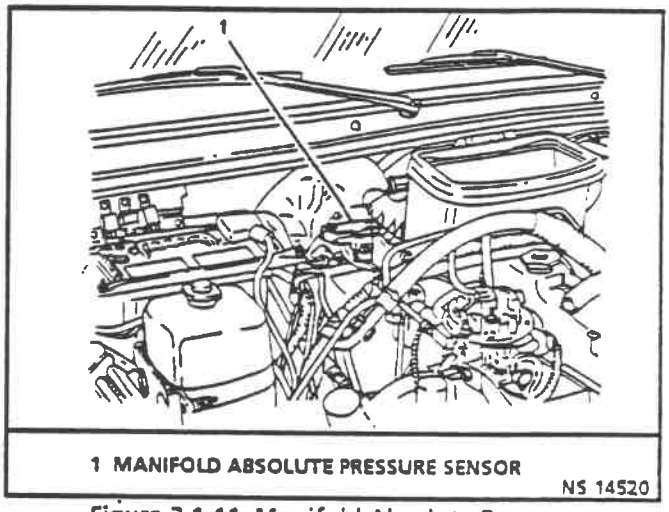


Figure 3.1-11 Manifold Absolute Pressure Sensor Location

MANIFOLD ABSOLUTE PRESSURE SENSOR
Figure 3.1-10 and 3.1-11

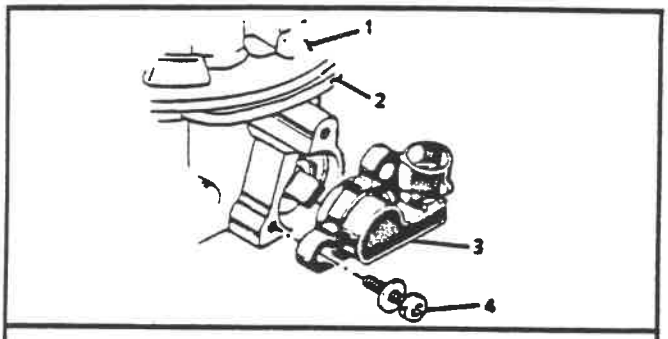
Other than checking for loose hoses and electrical connections, the only service possible is unit replacement if diagnosis shows sensor to be faulty.

Remove or Disconnect

1. Remove air cleaner.
2. Manifold absolute pressure hose.
3. Manifold absolute pressure electrical connector.
4. Mounting screws.
5. Manifold absolute pressure sensor.

Install or Connect

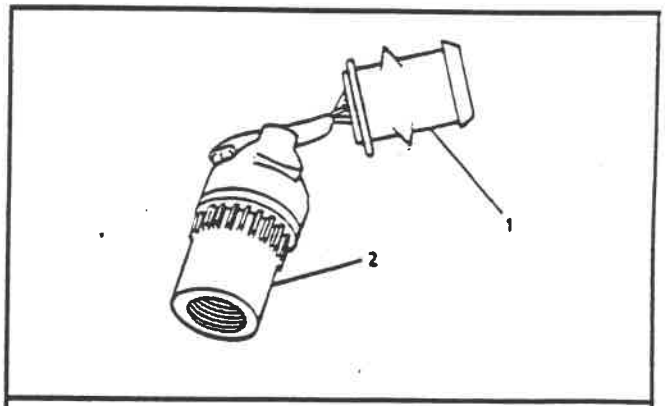
1. Manifold absolute pressure sensor.
2. Mounting screws.
3. Manifold absolute pressure electrical connector.
4. Manifold absolute pressure hose.
5. Air cleaner.



1 FUEL METER ASSEMBLY
2 THROTTLE BODY ASSEMBLY
3 THROTTLE POSITION SENSOR
4 THROTTLE POSITION SENSOR SCREW & WASHER ASSEMBLY

NS 14426

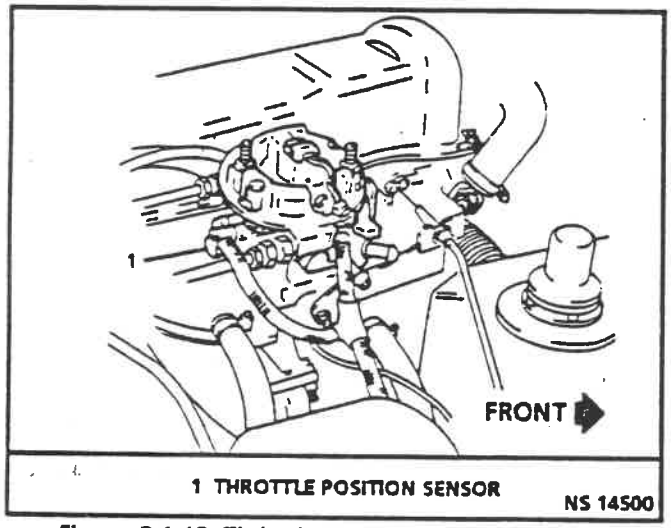
Figure 3.1-12 Throttle Position Sensor



1 ELECTRICAL CONNECTOR
2 VEHICLE SPEED SENSOR

NS 13180

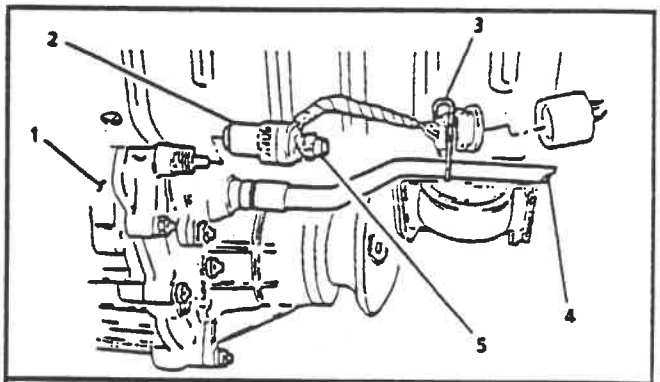
Figure 3.1-14 Vehicle Speed Sensor



1 THROTTLE POSITION SENSOR

NS 14500

Figure 3.1-13 Throttle Position Sensor Location



1 TRANSFER GEARCASE
2 VEHICLE SPEED SENSOR
3 WIRE TIE CABLE RETAINER
4 SPEEDOMETER CABLE
5 CAP

NS 13188

Figure 3.1-15 Vehicle Speed Sensor Location

THROTTLE POSITION SENSOR
Figure 3.1-12 and 3.1-13

Remove or Disconnect

1. Air cleaner.
2. Electrical connector.
3. Two throttle position sensor attaching screws and lock washers.
4. Sensor.

Install or Connect

1. Throttle position sensor on throttle body assembly with throttle valve in normal closed position, and throttle position sensor drive tangs aligned with flats on end of the shaft.
2. Throttle position sensor attaching screw and washer assembly on throttle position sensor assembly.
3. Electrical connector.
4. Air cleaner.

Tighten

- Attaching screws to 2.0 N·m (18 lb. in.).

VEHICLE SPEED SENSOR
Figure 3.1-14 and 3.1.-15

Remove or Disconnect

1. Three wire harness connectors.
2. Wire tie cable retainer that secures the vehicle speed sensor connector to the speedometer cable.
3. Vehicle speed sensor from transmission connection.

Install or Connect

1. Vehicle speed sensor to transmission connection.
2. Cable that secures the vehicle speed sensor to the speedometer.
3. Three wire harness connectors.

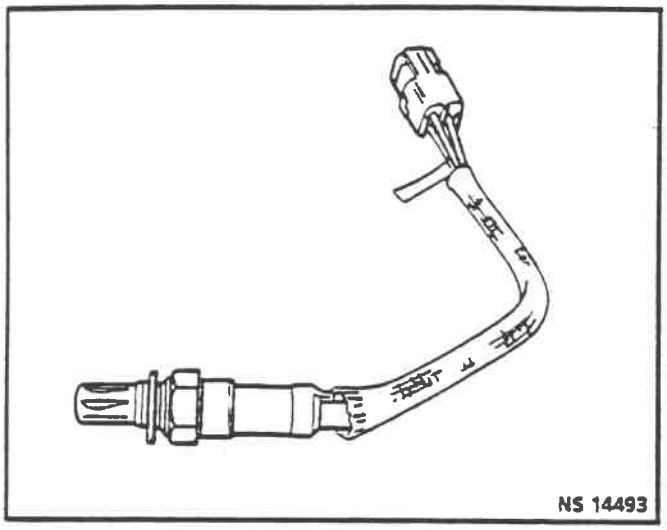


Figure 3.1-16 Oxygen Sensor

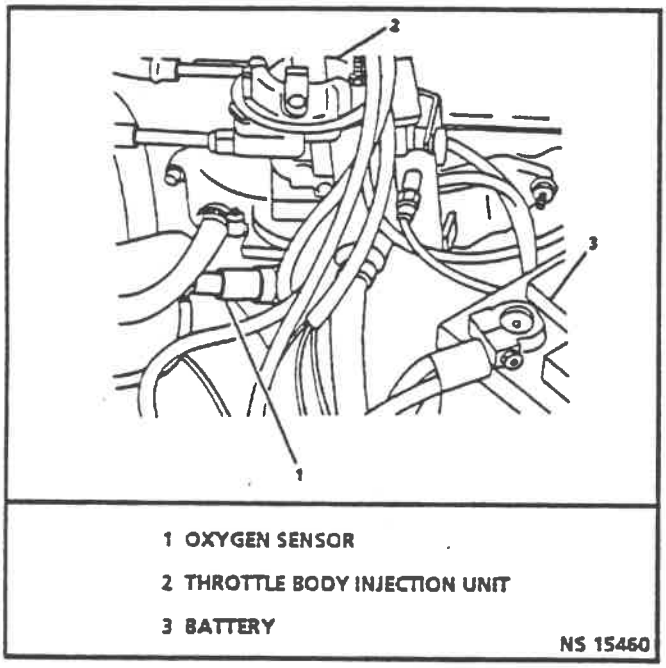


Figure 3.1-17 Oxygen Sensor Location

OXYGEN SENSOR

Figures 3.1-16 and 3.1-17

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector.
3. Carefully back out oxygen sensor.

- The oxygen sensor may be difficult to remove when engine temperature is below 48°C. Excessive force may damage threads in exhaust manifold or exhaust pipe.

Important

- Take care when handling the new oxygen sensor. The in-line electrical connector and louvered end must be kept free of grease, dirt or other contaminants. Also, avoid using cleaning solvents of any type. Do not drop or roughly handle the oxygen sensor.

Install or Connect

Important

- A special anti-seize compound is used on the oxygen sensor threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove.
- New or service sensors will already have the compound applied to the threads.

1. Sensor and torque to 41 N·m (30 lb. ft.).
2. Electrical connector.
3. Negative battery cable.

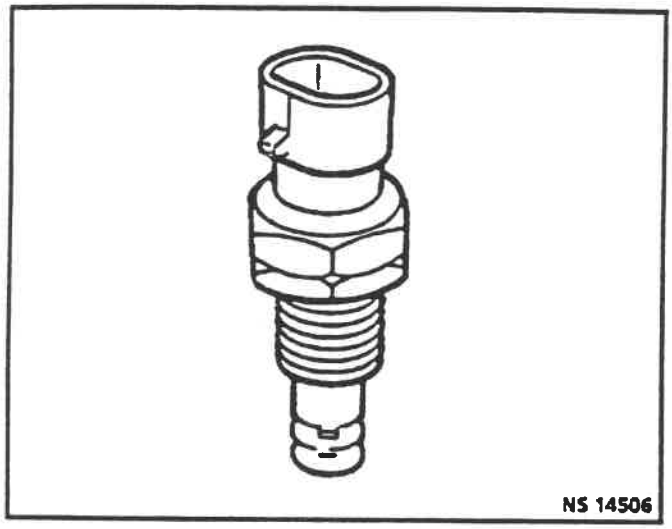


Figure 3.1-18 Intake Air Temperature Sensor

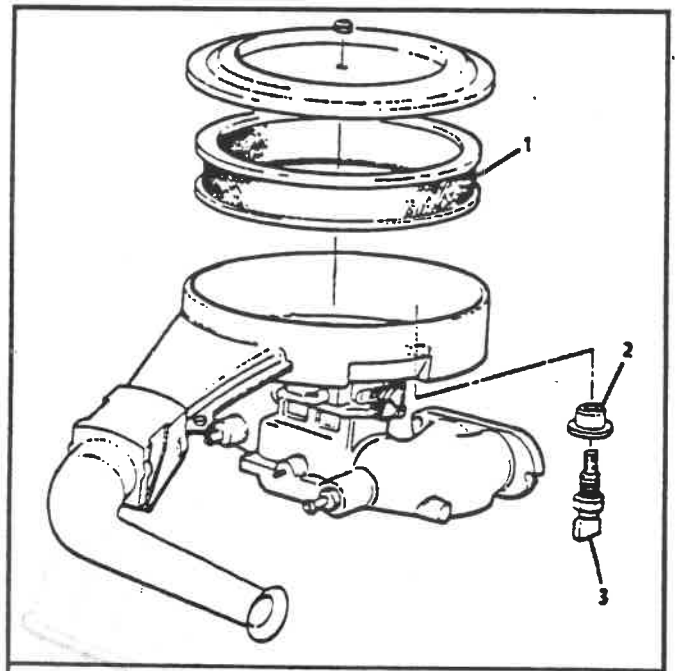


Figure 3.1-19 Intake Air Temperature Sensor Location View

INTAKE AIR TEMPERATURE SENSOR
Figures 3.1-18 and 3.1-19

The intake air temperature sensor is located in the air cleaner. The sensor is threaded into the air cleaner as shown in Figure 3.1-19. Be careful not to over tighten the sensor as you install it into the air cleaner.

Remove or Disconnect

1. Electrical connector.
2. Sensor.

Install or Connect

1. Sensor.
2. Electrical connector.

3.2 FUEL CONTROL SYSTEM

FUEL CONTROL

Always start with the "Diagnostic Circuit Check" in Section "2". This will reduce diagnosis time and prevent unnecessary replacement of parts. The information in this check will direct diagnosis concerning "Engine Cranks But Won't Run" and the Fuel Control System, including diagnosis of the injector, pressure regulator, fuel pump and fuel system relay.

Idle Air Control Valve

A Tech 1 "Scan" tool reads idle air control valve position in "Counts" (or steps). "0" steps indicates the electronic control module is commanding the idle air control valve to be driven in, to a fully seated position (minimum idle air). The higher the number of steps, the more idle air is being allowed to pass by the idle air control valve.

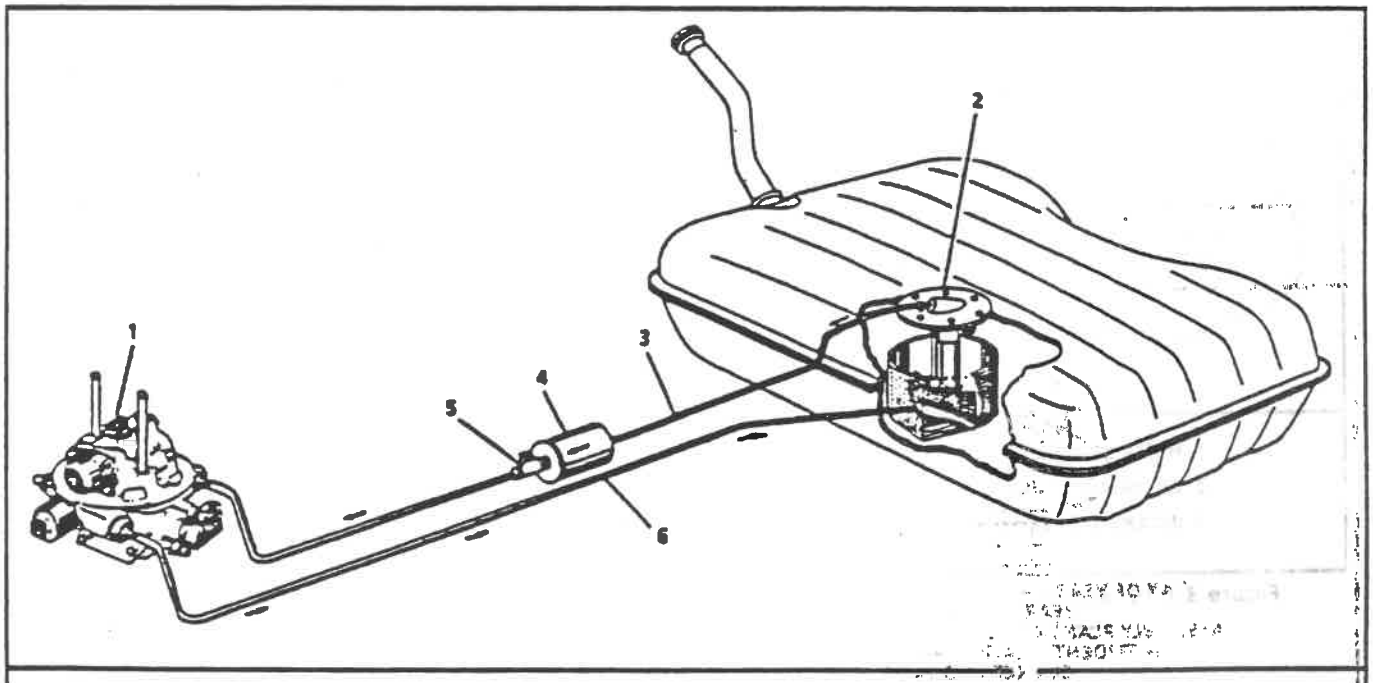
Refer to CHART C-2C to diagnose the operation of the idle air control valve.

ON-VEHICLE SERVICE

GENERAL SERVICE INFORMATION

CAUTION:

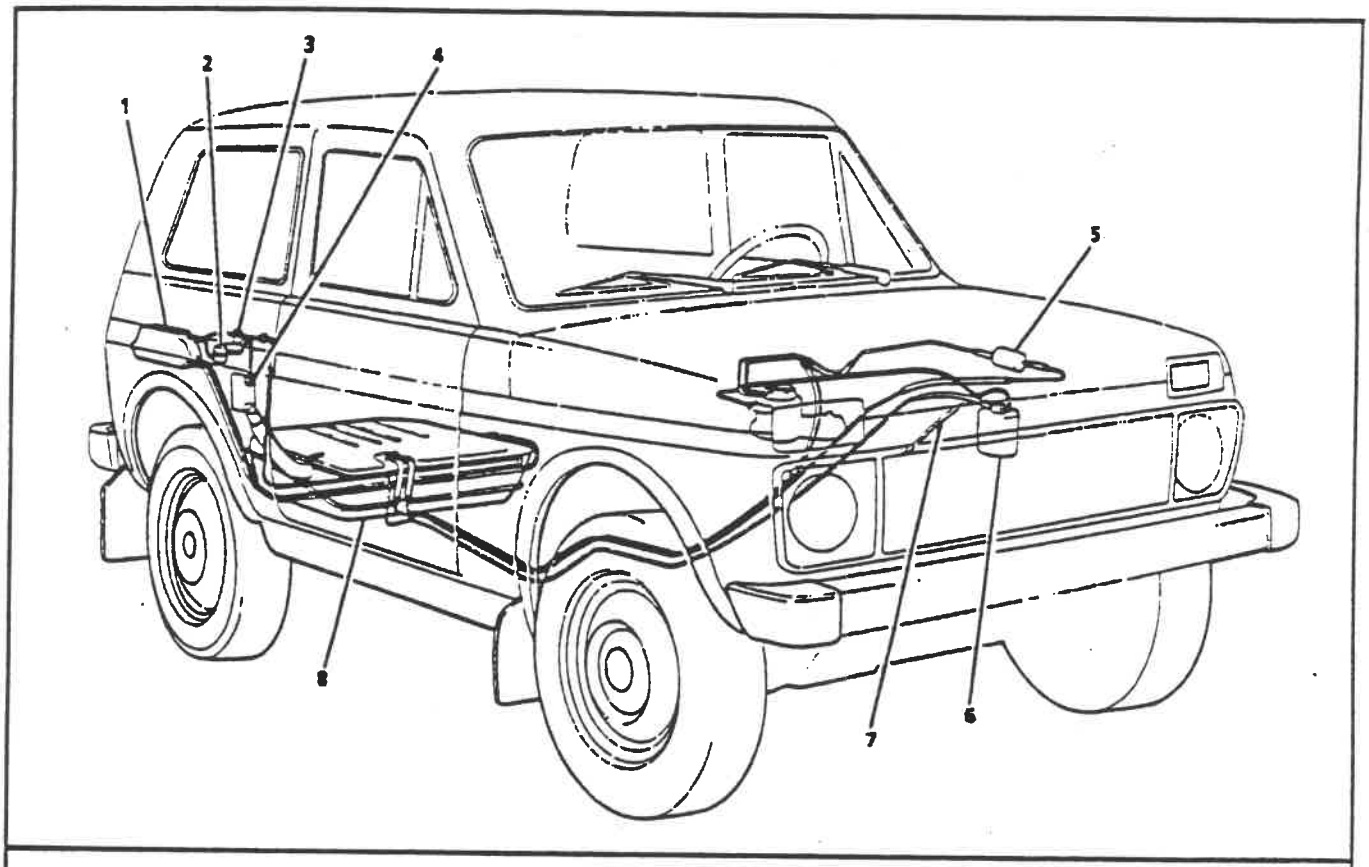
- **To prevent personal injury or damage to the vehicle as the result of an accidental start, disconnect and reconnect the negative battery cable before and after service is performed.**
- **To minimize the risk of fire or personal injury, relieve the fuel system pressure before servicing the throttle body injection unit or any of its fuel handling components. (See "Fuel Pressure Relief Procedure," page 3-28.)**
- **Also, catch any fuel that leaks out when disconnecting the fuel lines by covering the fittings with a shop cloth. Place the cloth in an approved container when work is complete.**



1 THROTTLE BODY INJECTOR UNIT
2 FUEL PUMP
3 FUEL SUPPLY PRESSURE LINE
4 FUEL FILTER
5 FUEL PRESSURE TEST FITTING (PART OF SPECIAL TOOL J 38970-V)
6 FUEL RETURN LINE

NS 14682

Figure 3.2-1 Fuel System



1 VAPOR LIQUID SEPARATOR
2 ROLL OVER VALVE
3 TANK PRESSURE CONTROL VALVE
4 BLOWOFF VALVE
5 FILTER
6 EVAPORATIVE LOSS CANISTER
7 AIR VENT PIPE
8 PUMP IN TANK

NS 14444

Figure 3.2-2 Additional Fuel System Components in Relation to Location on NIVA

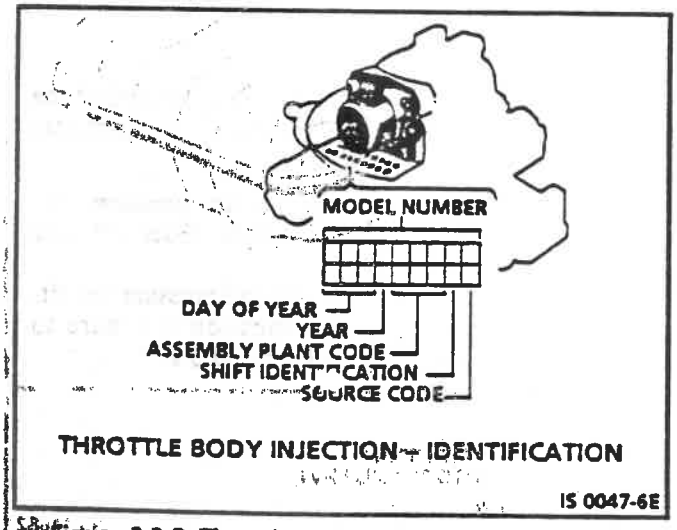


Figure 3.2-3 Throttle Body Injection Identification

The throttle body injection unit repair procedures cover component replacement with the unit on the vehicle. However, throttle body replacement requires that the complete unit be removed from the engine.

Refer to the disassembled view (Figure 3.2-2A, see Page 3-31) for identification of parts during repair procedures. Service repair of individual components is performed without removing the throttle body injection unit from the engine.

SERVICE IDENTIFICATION

The Model 700 throttle body injection unit is supplied with the following standard markings:

- Model Number.
- Day, Year, Plant, Shift and Source code.

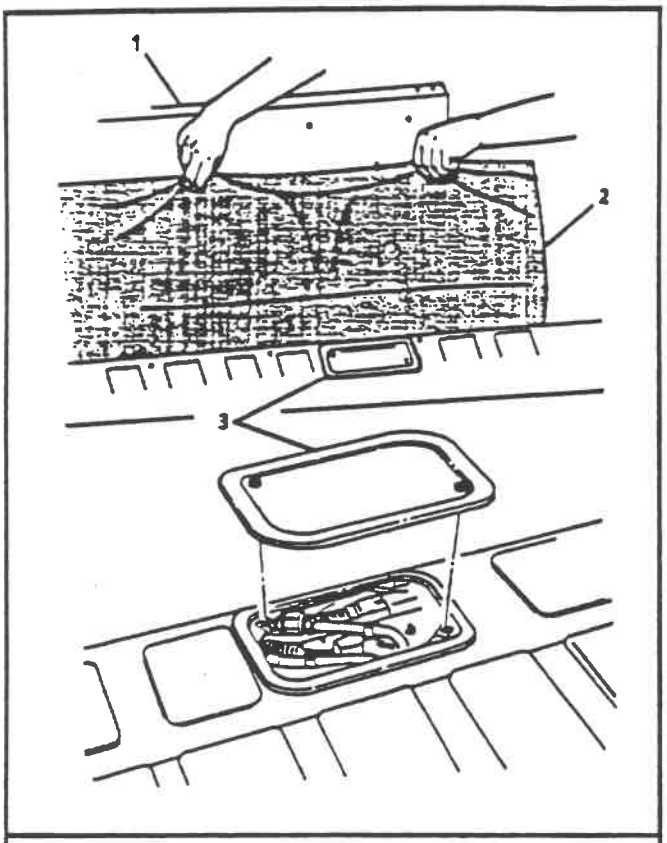


Figure 3.2-4 Fuel Pump Access Panel Location View

The fuel meter assembly is rollmarked with an eight (8) digit model number, date (Julian), year, assembly plant code, shift identification and source code. Figure 3.2-3 shows the rollmark format. Refer to this model number when replacement is required. If the throttle body injection is removed, it is essential that care is taken to prevent damage to the throttle valve or sealing surface while performing any service.

Whenever service is performed on the throttle body injection, first remove the air cleaner and air cleaner gasket. Discard the gasket and replace it with a new one before replacing the air cleaner after service is complete.

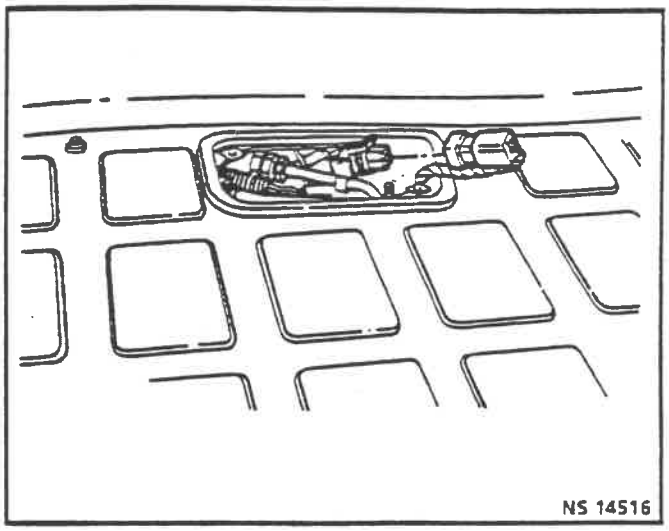


Figure 3.2-5 Fuel Pump Connector

FUEL PRESSURE RELIEF PROCEDURE

The throttle body injection Model 700 contains a "checking" fuel feature. This means that fuel pressure is maintained after the engine is shut "OFF." In order to bleed the system, the following procedure *must* be followed.

1. Place transmission selector in neutral, set parking brake, and block drive wheels.
2. Disconnect fuel pump connector at fuel pump (Figures 3.2-4 and 3.2-5).
3. Start engine and allow to idle until it stops running for lack of fuel.
4. Engage starter for three seconds to dissipate fuel pressure in lines. Fuel connections are now safe for servicing.
5. When pressure is relieved and servicing is complete, reconnect fuel pump connector.

FUEL SYSTEM PRESSURE TEST

A fuel system pressure test is part of several of the diagnostic charts and symptom checks. To perform this test, follow this procedure:

1. Turn engine "OFF" and relieve fuel pressure, following previous instructions under "Fuel Pressure Relief Procedure."
2. Install fuel pressure gauge onto fuel pressure test fitting making certain the connection is secure to avoid leaking fuel (Figures 3.2-6 and 3.2-7).

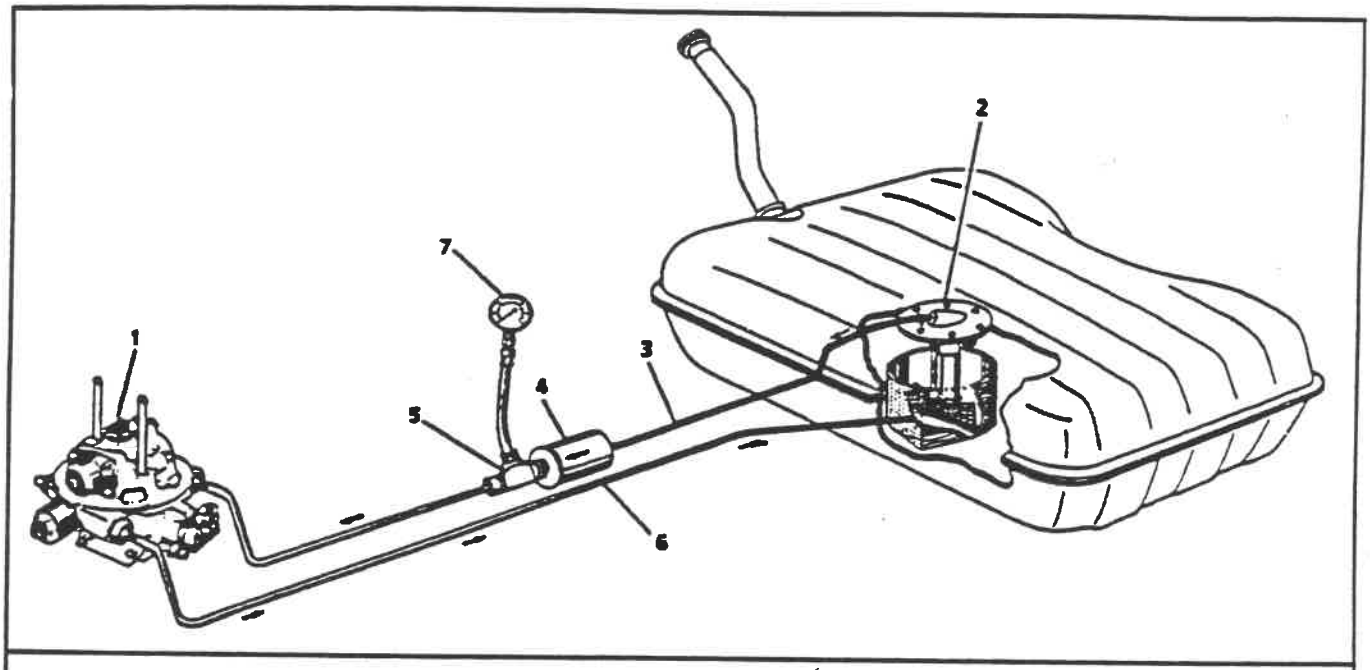


Figure 3.2-6 Fuel Pressure Test

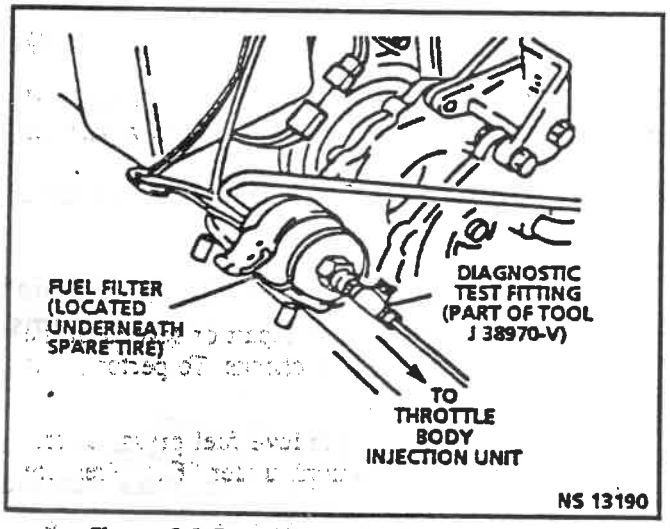

FUEL FILTER (LOCATED UNDERNEATH SPARE TIRE)
DIAGNOSTIC TEST FITTING (PART OF TOOL J 38970-V)
TO THROTTLE BODY INJECTION UNIT
NS 13190

Figure 3.2-7 Fuel Pressure Fitting Location

3. Energize fuel system relay by turning ignition key to the "ON" position. Observe fuel pressure reading, it should be 191.6 to 206.8 kPa (27.8 to 30 psi, 1.9 to 2.1 bar). If not, refer to Chart A-5 or A-7.
4. Relieve fuel pressure. (See "Fuel Pressure Relief.")
5. Remove fuel pressure gauge from fuel pressure test fitting.
6. Start vehicle and check for fuel leaks.
7. Install air cleaner.

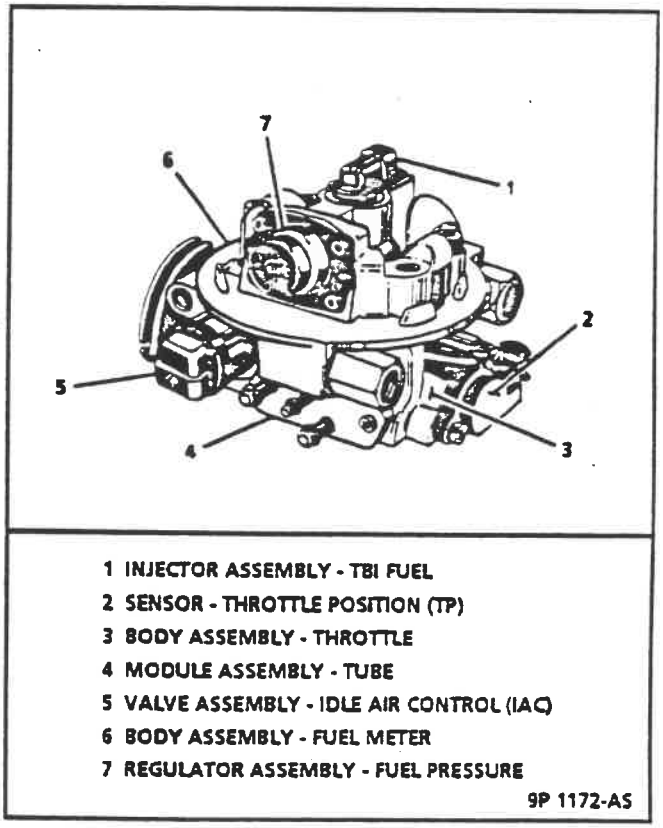
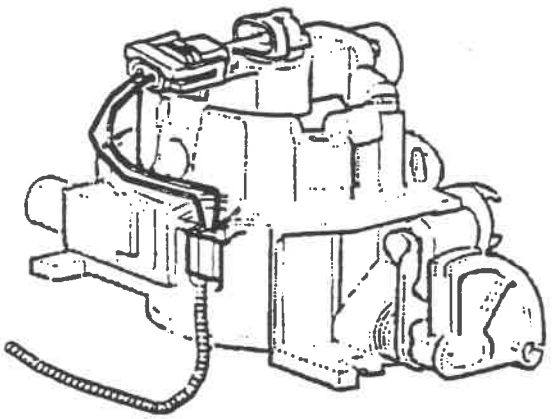
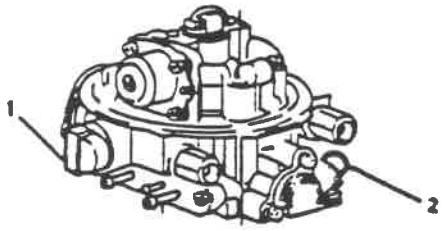


Figure 3.2-8 Throttle Body Injection 700 Components



MS 11131

Figure 3.2-9 Throttle Body Injection Injector Electrical Connector



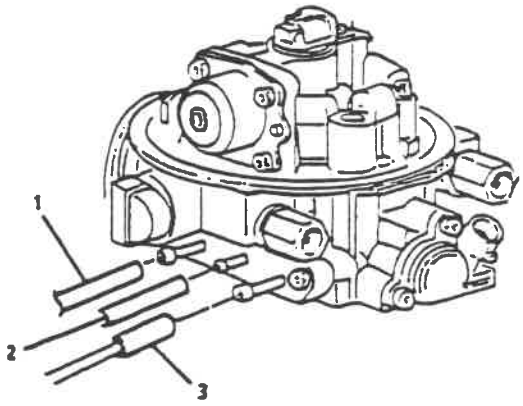
1 IDLE AIR CONTROL (IAC) CONNECTOR

2 THROTTLE POSITION SENSOR (TPS) CONNECTOR

MS 11130

Figure 3.2-10 Throttle Body Injection Wiring

GASOLINE



1 MANIFOLD ABSOLUTE PRESSURE SENSOR

2 CRANKCASE VENTILATION

3 EVAPORATIVE EMISSION CONTROL SYSTEM

NS 14687

Figure 3.2-11 Vacuum Hoses

THROTTLE BODY INJECTION UNIT

If the throttle body injection unit is removed, it is essential that care is taken to prevent damage to the throttle valve or sealing surface while performing any service.

When a service throttle body injection unit is installed, first remove the air cleaner and air cleaner gasket. Discard the gasket and replace it with a new one before replacing the air cleaner after service is complete.

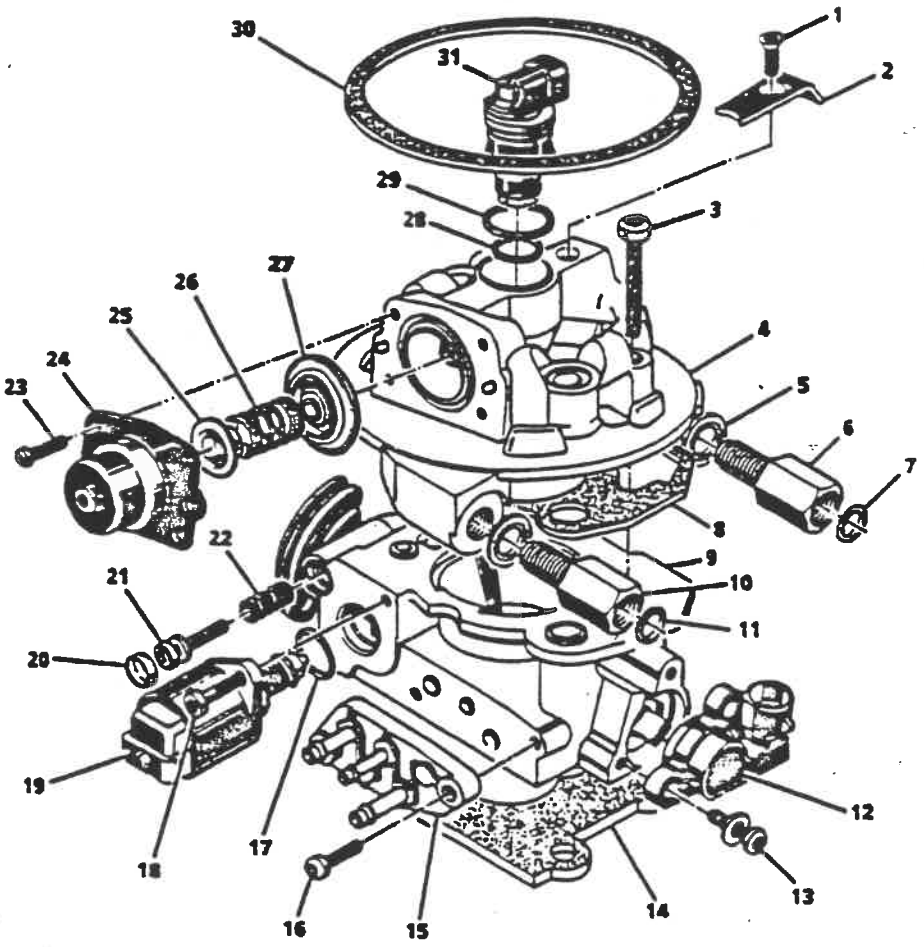
Remove or Disconnect

1. Electrical connectors for idle air control valve, throttle position sensor, and fuel injector (Figure 3.2-10);
2. Grommet with injector wires from throttle body injection assembly (Figure 3.2-9);
3. Throttle linkage.
4. Vacuum hoses, noting positions of hoses (Figure 3.2-11);
5. Inlet and outlet fuel hose nuts, using back-up wrench (Figure 3.2-12).

CAUTION: Refer to fuel pressure relief procedure before servicing fuel systems. See page 3-28.

6. Fuel line O-rings from nuts and discard.
7. Throttle body injection mounting hardware.
8. Throttle body injection unit from intake manifold (Figure 3.2-13).
9. Throttle body injection flange (manifold mounting) gasket and discard.

NOTICE: Stuff the manifold opening with a rag to prevent material from entering the engine, and remove the old gasket materials from surface of intake manifold.



1 SCREW - INJECTOR RETAINER ATTACHING
2 RETAINER - INJECTOR
3 SCREW - FUEL METER BODY - THROTTLE BODY
4 FUEL METER BODY ASSEMBLY
5 SEAL - FUEL FITTING
6 FITTING - FUEL INLET
7 O-RING, FUEL LINE INLET NUT
8 GASKET - FUEL METER BODY TO THROTTLE BODY
9 THROTTLE BODY ASSEMBLY
10 FITTING - FUEL OUTLET
11 O-RING, FUEL LINE OUTLET NUT
12 SENSOR, THROTTLE POSITION (TPS)
13 SCREW ASSEMBLY - TPS ATTACHING
14 GASKET - FLANGE
15 TUBE MODULE ASSEMBLY
16 SCREW - TUBE MODULE ASSEMBLY
17 O-RING, IAC VALVE
18 SCREW - IAC VALVE ATTACHING
19 IDLE AIR CONTROL (IAC) VALVE ASSEMBLY
20 PLUG - IDLE STOP SCREW
21 IDLE STOP SCREW ASSEMBLY
22 SPRING - IDLE STOP SCREW
23 SCREW - PRESSURE REGULATOR ATTACHING
24 PRESSURE REGULATOR COVER ASSEMBLY
25 SEAT - PRESSURE REGULATOR SPRING
26 SPRING - PRESSURE REGULATOR
27 PRESSURE REGULATOR DIAPHRAGM ASSEMBLY
28 O-RING - FUEL INJECTOR - LOWER
29 O-RING - FUEL INJECTOR - UPPER
30 GASKET - AIR CLEANER
31 TBI INJECTOR ASSEMBLY

PS 17728

Figure 3.2-2A Model 700 Throttle Body Injection Parts Identification

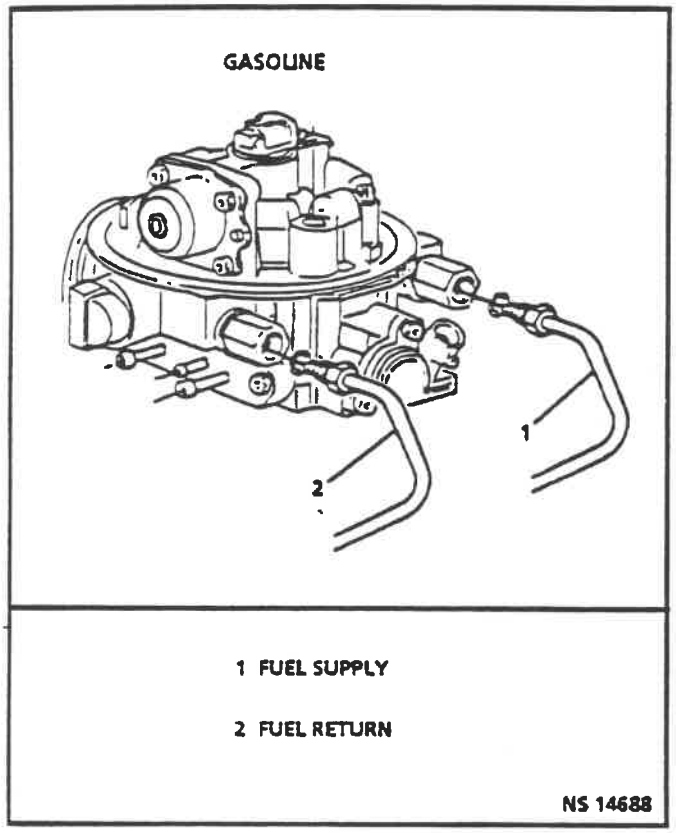


Figure 3.2-12 Fuel Hoses

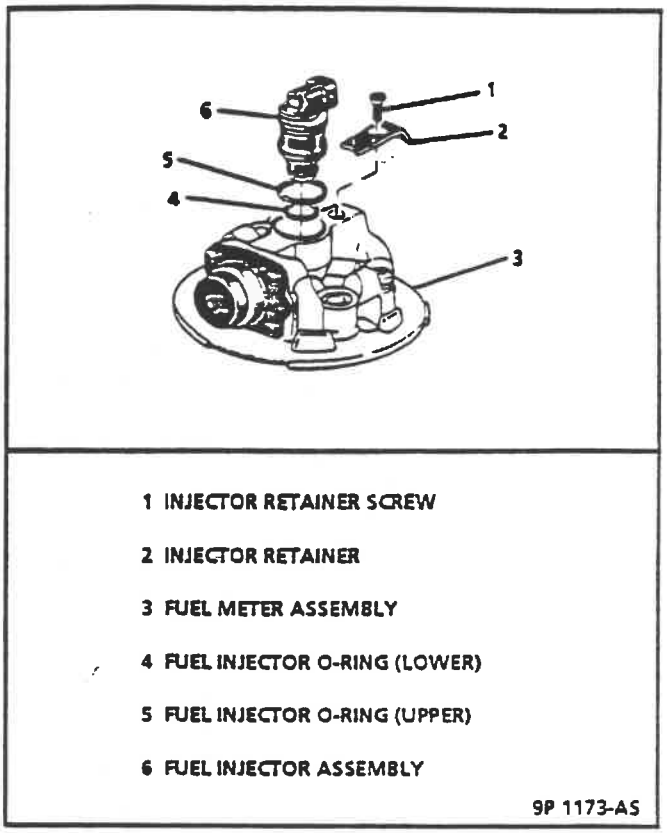


Figure 3.2-14 Fuel Injector Components

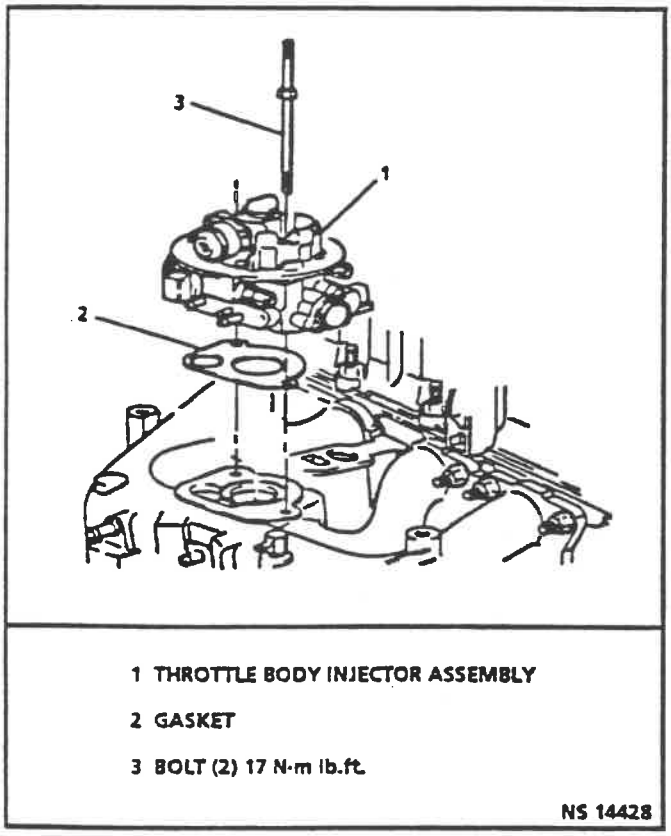


Figure 3.2-13 Removing Throttle Body Injection 700 Unit

Clean and Inspect

NOTICE: The throttle position sensor, idle air control valve, pressure regulator diaphragm assembly, fuel injector, or other components containing rubber. SHOULD NOT be placed in a solvent or cleaner bath. A chemical reaction will cause these parts to swell, harden or distort. Do not soak the throttle body with the above parts attached. If the throttle body requires cleaning, soaking time in the cleaner should be kept to a minimum. Some models have hidden throttle shaft dust seals that could lose their effectiveness by extended soaking.

1. Clean all metal parts thoroughly, and blow dry with shop air. Be sure that all fuel and air passages are free of dirt or burrs.
2. Inspect mating casting surfaces for damage that could affect gasket sealing.

- Manifold bore for loose parts, foreign material, etc.
- Intake manifold sealing surfaces for cleanliness.

Install or Connect

1. New throttle body injection flange (manifold mounting) gasket
2. Throttle body injection with mounting hardware.

Tighten

- Mounting hardware to 17 N·m (12 lb. ft.).

3. New O-rings on fuel line nuts.
4. Fuel line inlet and outlet nuts by hand.

Tighten

- Inlet and outlet nuts to 27 N·m (20 lb. ft.) (Use backup wrench to keep throttle body injection nuts from turning.)

5. Vacuum hoses.
6. Throttle linkage.
7. Grommet with wires to fuel meter assembly.
8. Electrical connectors, making sure connectors are fully seated and latched.
9. Check to see if accelerator pedal is free by depressing pedal to the floor and releasing while engine is "OFF." Check for correct Wide Open Throttle adjustment.
10. Energize the fuel system relay by turning the ignition key to the "ON" position and check for leaks.
11. Start engine and check for fuel leaks.

FUEL INJECTOR ASSEMBLY

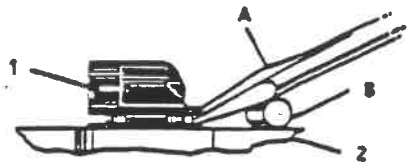
Figures 3.2-14, 3.2-15, 3.2-16 and 3.2-17

CAUTION: Refer to fuel pressure relief procedure before servicing fuel systems. See page 3-28.

Replacement

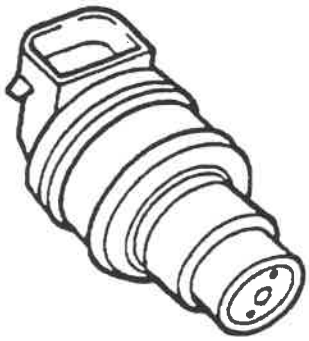
The fuel injector is serviced only as a complete assembly.

NOTICE: Use care in removing injector, to prevent damage to the electrical connector on top of the injector, and nozzle. Also, because the fuel injector is an electrical component, it should not be immersed in any type of liquid solvent or cleaner, as damage may occur.



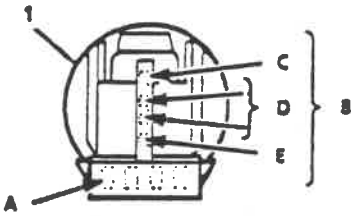
A SCREWDRIVER BLADE
B FULCRUM
1 FUEL INJECTOR ASSEMBLY
2 FUEL METER BODY
8P 0912-AS

Figure 3.2-15 Removing Throttle Body Injection 700 Fuel Injector



NS 14499

Figure 3.2-16 Fuel Injector



1 FUEL INJECTOR (TOP VIEW)
A PART NUMBER
B BUIL DATE CODE
C MONTH
1-9 (JAN-SEP)
O, N, D (OCT, NOV, DEC)
D DAY
E YEAR
8P 0913-AS

Figure 3.2-17 Fuel Injector Part Number Location

Remove or Disconnect

1. Electrical connector to fuel injector.
2. Injector retainer screw and retainer.
3. Using a fulcrum, place screwdriver blade under ridge opposite connector end and carefully pry injector out (Figure 3.2-15).
4. Remove upper and lower O-rings from injector and in fuel injector cavity and discard.

Inspect

- Fuel injector filters for evidence of dirt and contamination. The upper (large diameter) filter is the purge filter, the lower (smaller diameter) filter is the inlet filter. If present, check for presence of dirt in fuel lines and fuel tank.

Important

- Be sure to replace the injector with an identical part. Injectors from other models can fit in the Model 700 throttle body injection, but are calibrated for different flow rates. (See Figure 3.2-17 for part number location.)

Install or Connect

1. Lubricate new upper and lower O-rings with automatic transmission fluid and place them on injector. (Make sure upper O-ring is in groove and lower one is flush up against inlet filter-smaller.)
2. Injector assembly, pushing it straight into fuel injector cavity.

Important

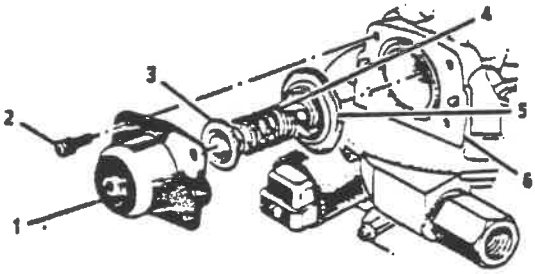
- Be sure the electrical connector end on the injector is facing in the general direction of the cut-out in the fuel meter body for the wire grommet.

3. Injector retainer, using appropriate thread locking compound on retainer attaching screw.
4. Electrical connector to fuel injector.

Tighten

- Injector retainer attaching screw to 3.0 N·m (28.0 lb. in.).

5. Energize the fuel system relay by turning the ignition key to the "ON" position and check for leaks.



1 PRESSURE REGULATOR COVER ASSEMBLY
2 COVER SCREW AND WASHER ASSEMBLY
3 SPRING SEAT
4 SPRING
5 DIAPHRAGM ASSEMBLY
6 FUEL METER ASSEMBLY

8P 0914-AS

Figure 3.2-18 Throttle Body Injection 700 Pressure Regulator

PRESSURE REGULATOR ASSEMBLY

CAUTION: Refer to fuel pressure relief procedure before servicing fuel systems. See page 3-28.

Replacement
Figure 3.2-18

NOTICE: To prevent leaks, the pressure regulator diaphragm assembly *must be replaced* whenever the cover is removed.

Remove or Disconnect

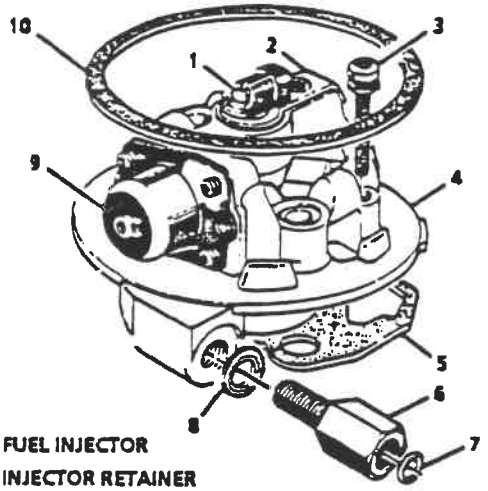
1. Four pressure regulator attaching screws, while keeping pressure regulator compressed.

CAUTION: The pressure regulator contains a large spring under heavy compression. Use care when removing the screws to prevent personal injury.

2. Pressure regulator cover assembly.
3. Pressure regulator spring.
4. Spring seat.
5. Pressure regulator diaphragm assembly.

Inspect

- Pressure regulator seat in fuel meter body cavity for pitting, nicks, or irregularities. (Use magnifying glass if necessary). If any of above is present, the whole fuel body casting *must be replaced.*



1 FUEL INJECTOR
2 INJECTOR RETAINER
3 FUEL METER BODY ATTACHING SCREW AND WASHER ASSEMBLY
4 FUEL METER ASSEMBLY
5 FUEL METER BODY TO THROTTLE BODY GASKET
6 FUEL OUTLET NUT
7 FUEL LINE OUTLET NUT O-RING
8 FUEL NUT SEAL
9 PRESSURE REGULATOR COVER ASSEMBLY
10 AIR FILTER GASKET

8P 0915-AS

Figure 3.2-19 Fuel Meter Assembly

Install or Connect

1. New pressure regulator diaphragm assembly, making sure it is seated in groove in fuel meter body.
2. Regulator spring seat and spring into cover assembly.
3. Cover assembly over diaphragm, while aligning mounting holes.

NOTICE: Use care while installing the pressure regulator to prevent misalignment of diaphragm and possible leaks.

4. Four screw assemblies that have been coated with appropriate thread locking compound, while maintaining pressure on regulator spring.

Tighten

- Attaching screw assemblies to 2.5 N·m (22.0 lb. in.).

5. Energize the fuel system relay by turning the ignition key to the "ON" position and check for leaks.

FUEL METER ASSEMBLY

CAUTION: Refer to fuel pressure relief procedure before servicing fuel systems. See page 3-28.

Replacement
Figure 3.2-19

Remove or Disconnect

1. Electrical connector from fuel injector.
2. Grommet with wires from fuel meter assembly.
3. Inlet and outlet fuel line nuts, using back-up wrench.
4. Fuel line O-rings from nuts and discard.
5. Throttle body injection mounting hardware.
6. Two fuel meter body attaching screw and washer assemblies.
7. Fuel meter assembly from throttle body assembly.
8. Fuel meter body to throttle body gasket and discard.

Install or Connect

1. New fuel meter body to throttle body gasket. Match cut-out portions of gasket with openings in throttle body assembly.
2. Fuel meter assembly.
3. Two fuel meter body attaching screw and washer assemblies that have been coated with appropriate locking compound.

Tighten

- Attaching screws to 6.0 N·m (53 lb. in.).

4. Throttle body injection unit mounting hardware.

Tighten

- Mounting hardware to 17 N·m (12 lb. ft.).

5. New O-rings on fuel line nuts.
6. Fuel line inlet and outlet nuts by hand.

Tighten

- Inlet and outlet nuts to 27 N·m (20 lb. ft.). (Use back-up wrench to keep throttle body injection nuts from turning.)

7. Grommet with wires to fuel meter assembly.
8. Electrical connector to fuel injector, making sure it is fully seated and latched.
9. Energize the fuel system relay by turning the ignition key to the "ON" position and check for leaks.

THROTTLE POSITION SENSOR
Replacement
Figure 3.2-20

Remove or Disconnect

1. Electrical connector from throttle position sensor.
2. Screw assemblies and throttle position sensor.

NOTICE: The throttle position sensor is an electrical component and should not be immersed in any type of liquid solvent or cleaner, as damage may result.

Install or Connect

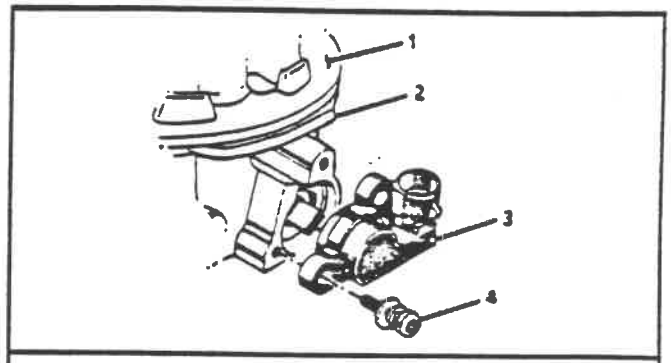
1. With throttle valve in normally closed position, install throttle position sensor on throttle shaft and rotate counterclockwise to align mounting holes.
2. Attaching screw and washer assemblies.

Tighten

- Screw assemblies to 2.0 N·m (18.0 lb. in.).

3. Electrical connector to throttle position sensor.
4. Check for throttle position sensor output as follows:

- Connect Tech 1 to read throttle position sensor output voltage.
- With ignition "ON" and engine stopped, throttle position sensor voltage should be less than 1.25 volts. If more than 1.25 volts, replace throttle position sensor.



1 FUEL METER ASSEMBLY
2 THROTTLE BODY ASSEMBLY
3 THROTTLE POSITION SENSOR
4 TPS ATTACHING SCREW AND WASHER ASSEMBLY

8P 0916-AS

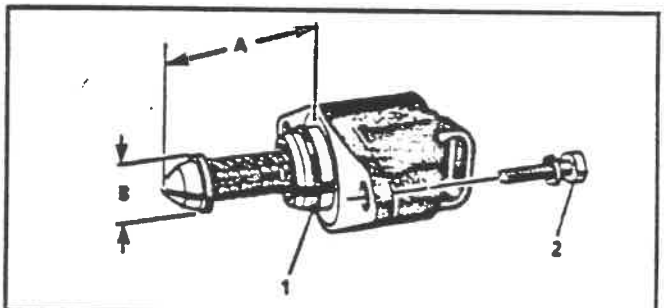
Figure 3.2-20 Throttle Position Sensor

IDLE AIR CONTROL VALVE
Replacement
Figure 3.2-21

NOTICE: The idle air control valve is an electrical component and must not be soaked in any liquid cleaner or solvent. Otherwise, damage could result.

Important

- On throttle body injection Model 700, the idle air control valve is flange-mounted, with a dual taper, 10 mm diameter pintle. If replacement is necessary, only an idle air control valve identified with the correct part number (having the appropriate pintle shape and diameter) should be used.



1 IDLE AIR CONTROL VALVE O-RING
2 IDLE AIR CONTROL VALVE ATTACHING SCREW ASSEMBLY
A DISTANCE OF PINTLE EXTENSION
B DIAMETER OF PINTLE

NS 14429

Figure 3.2-21 Flange-Mount Idle Air Control Valve

Remove or Disconnect

1. Electrical connector from idle air control valve.
2. Screw assemblies and idle air control valve.
3. Idle air control valve O-ring and discard. New O-ring is included in service replacement kit.

NOTICE: Before inserting the idle air control valve assembly, measure the distance from the idle air control valve mounting flange to the point of the idle air control valve pintle. If the pintle is extended too far, damage to the idle air control valve assembly may result. (Figure 3.2-21).

Measure

- Distance from idle air control valve mounting flange to the point of pintle. Distance *must be* less than 28 mm.

Adjust, if necessary

- If distance is greater than 28 mm, apply firm hand pressure to retract it. (A slight side-to-side motion may be helpful.)

Install or Connect

1. New O-ring on idle air control valve.
2. Idle air control assembly in throttle body assembly with attaching screws.
3. Electrical connector to idle air control valve.

Important

- No adjustment of the idle air control valve is made after installation. With the Tech 1 connected and engine running, select "Miscellaneous Tests," then "Idle System," then "Idle Reset." This will command the electronic control module to reset the idle air control valve.

TUBE MODULE ASSEMBLY

Replacement
Figure 3.2-22

Remove or Disconnect

1. Tube module assembly attaching screws.
2. Tube module assembly.
3. Tube module assembly gasket (O-ring) and discard.

Clean

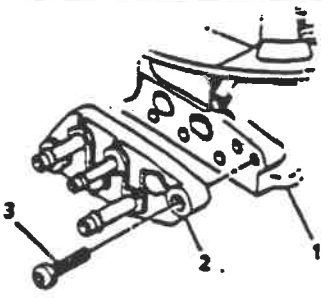
- Old gasket (O-ring) material from surface of throttle body assembly to ensure proper seal of new gasket (O-ring).

Install or Connect

1. New tube module assembly gasket (O-ring).
2. Tube module assembly.
3. Tube module assembly attaching screws.

Tighten

- Screw assemblies to 3.0 N·m (28.0 lb.in.).



1 THROTTLE BODY ASSEMBLY

2 TUBE MODULE ASSEMBLY

3 TUBE MODULE SCREW ASSEMBLY

PS 17729

Figure 3.2-22 Tube Module Assembly

THROTTLE BODY ASSEMBLY

CAUTION: Refer to fuel pressure relief procedure before servicing fuel systems. See page 3-28.

Replacement
Figure 3.2-23

NOTICE: Procedures related to replacement of the individual components below have been described previously and should be followed or damage could occur.

Remove or Disconnect

1. Throttle body injection unit, as described above.
2. Fuel meter body-to-throttle body attaching screw and washer assemblies.
3. Fuel meter assembly.
4. Fuel meter body to throttle body gasket and discard.

Disassemble

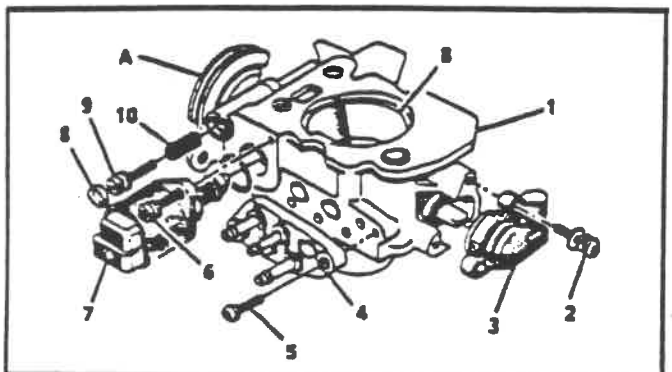
- Throttle position sensor, idle air control valve and tube module assembly from old throttle body assembly, according to previous instructions.

Assemble

- Throttle position sensor, idle air control valve, and tube module assembly onto replacement throttle body assembly, according to previous instructions.

Install or Connect

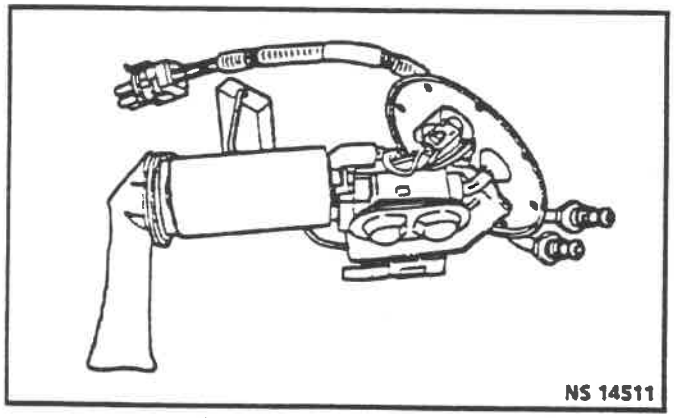
1. New fuel meter body to throttle body gasket.
2. Fuel meter assembly on throttle body assembly.
3. Fuel meter body-to-throttle body attaching screw and washer assemblies.



A THROTTLE LEVER
B THROTTLE BORE
1 THROTTLE BODY ASSEMBLY
2 THROTTLE POSITION SENSOR ATTACHING SCREW & WASHER ASSEMBLY
3 THROTTLE POSITION SENSOR
4 TUBE MODULE ASSEMBLY
5 TUBE MODULE ATTACHING SCREW ASSEMBLY
6 IDLE AIR CONTROL VALVE ATTACHING SCREW
7 IDLE AIR CONTROL VALVE
8 IDLE STOP SCREW PLUG
9 IDLE STOP SCREW AND WASHER ASSEMBLY
10 IDLE STOP SCREW SPRING

PS 17730

Figure 3.2-23 Throttle Body Assembly - Typical



NS 14511

Figure 3.2-24 Fuel Pump

Tighten

- Screws to 6.0 N·m (53 lb. in.).

4. Throttle body injection unit onto engine, as described in "Throttle Body Injection Unit."

FUEL PUMP

CAUTION: Refer to fuel pressure relief procedure before servicing fuel systems. See page 3-28.

Replacement

The fuel pump (see Figure 3.2-24) is a roller vane type, electric pump, mounted inside of the fuel tank.

Fuel is pumped at a positive pressure above 190.2 kPa (27.6 psi, 1.9 bar) from the fuel pump through the in-line filter to the pressure regulator in the throttle body injection assembly. Excess fuel is returned to the fuel tank through the fuel return line.

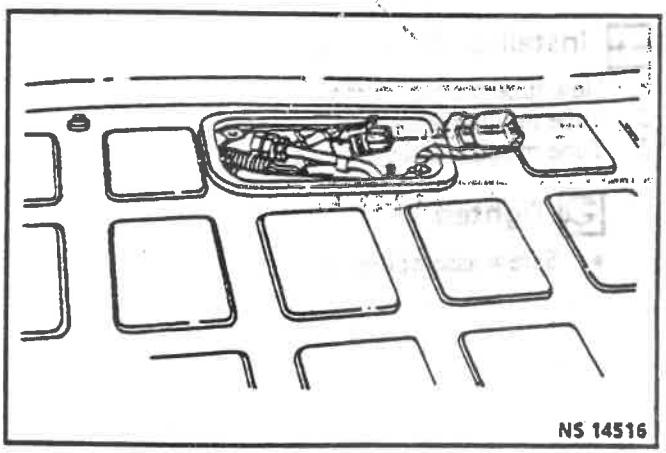
Vapor lock problems are reduced when using an electric pump because the fuel is pushed under pressure rather than pulled under vacuum, a condition that produces vapor.

Remove or Disconnect

1. Fold rear seat forward and lift up mat covering storage area.
2. Fuel pump access cover.
3. Fuel pump electrical connector (Figure 3.2-4 and 3.2-25).
4. Fuel lines.
5. Fuel tank from vehicle after removing hold down straps and bolts.
6. Fuel pump retaining bolts and carefully remove pump from tank.

Install or Connect

1. New fuel pump into fuel tank.
2. Fuel pump retaining bolts. Tighten securely.
3. Fuel tank under vehicle and secure using hold down straps and bolts.
4. Fuel lines.



NS 14516

Figure 3.2-25 Fuel Pump Connector

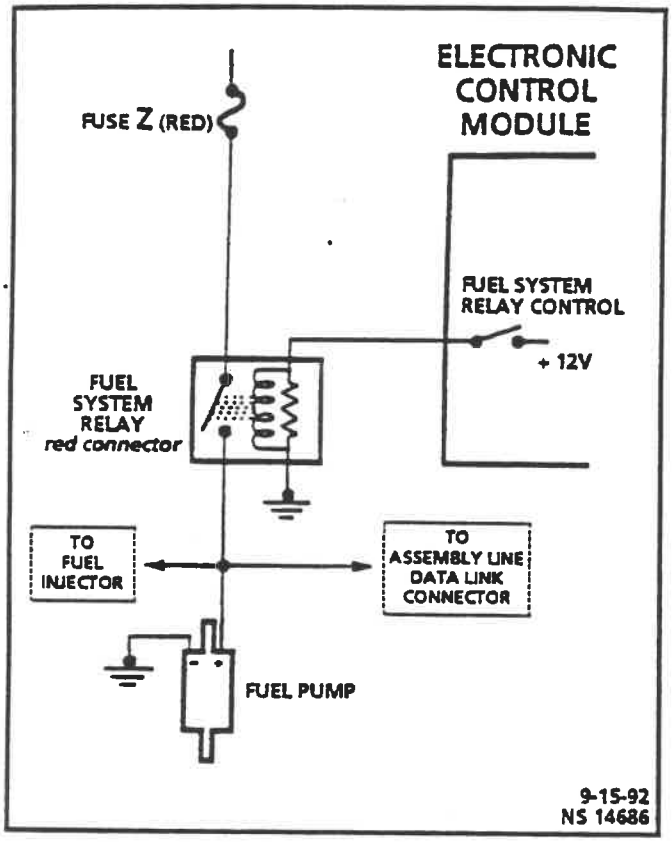


Figure 3.2-26 Fuel Pump Electrical Circuit

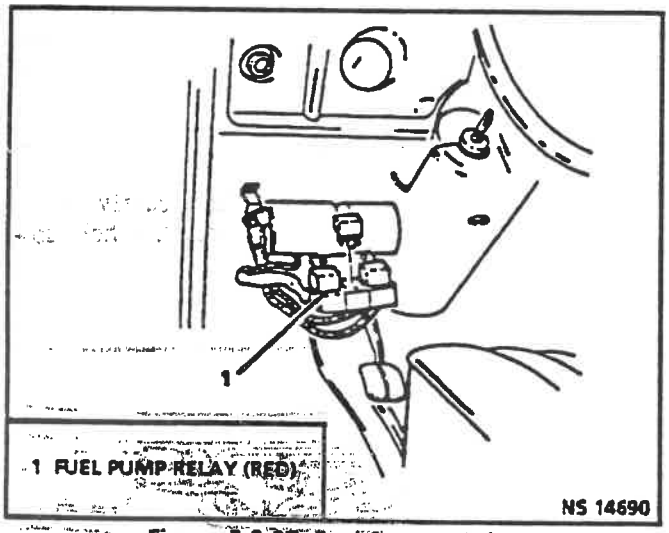


Figure 3.2-27 Fuel System Relay

5. Fuel pump electrical connector.
6. Fuel pump access cover.
7. Return rear seat to normal position.

Energize the fuel system relay by turning the ignition key to the "ON" position and check for leaks.

FUEL PUMP ELECTRICAL CIRCUIT
Figure 3.2-26

When the ignition is first turned "ON" without the engine running, the electronic control module will turn the fuel pump relay "ON" for two seconds. This builds up the fuel pressure quickly. If the engine is not cranked within two seconds, the electronic control module will shut the fuel pump "OFF" and wait for the reference signal. As soon as the engine is cranked, the electronic control module will turn the relay "ON" and run the fuel pump.

FUEL SYSTEM RELAY
Figure 3.2-27

The fuel system relay is mounted in the fuse panel. Other than checking for loose connectors, the only service possible is replacement (see Figure 3.2-27).

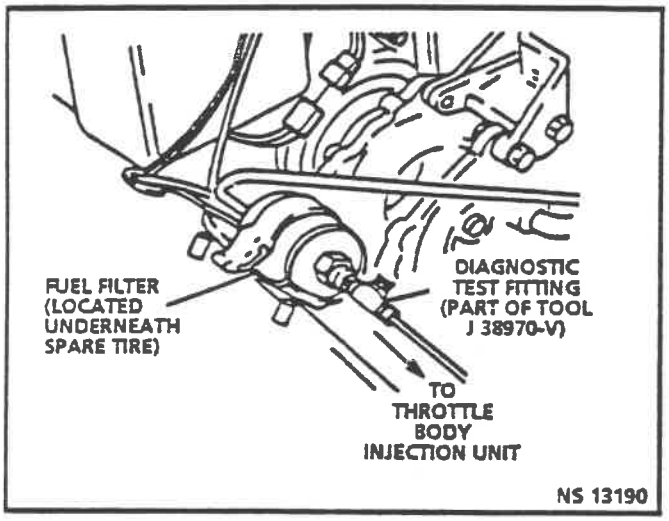


Figure 3.2-28 Fuel Filter

FUEL FILTER

CAUTION: Refer to fuel pressure relief procedure before servicing fuel systems. See page 3-28.

Replacement
Figure 3.2-28

Important

- Before proceeding, refer to the "Fuel Pressure Relief" procedure found earlier in this section.

Remove or Disconnect

1. Fuel line to fuel filter attachment nuts. (Be careful not to lose the O-rings that are installed between the fuel filter and fuel lines.)
2. Fuel filter hold down strap.

Important

- Inspect O-rings for cuts, nicks or abrasions. Replace if necessary.

Install or Connect

1. Fuel filter hold-down strap.
2. Fuel line to fuel filter attachment nuts, including the rubber O-rings.

Energize the fuel system relay by turning the ignition key to the "ON" position and check for leaks.

3.3 EVAPORATIVE EMISSION CONTROL SYSTEM

ON-VEHICLE SERVICE

VISUAL CHECK OF CANISTER

- Cracked or damaged, replace canister.
- Fuel leaking from bottom of canister vent hose, replace canister and check hoses and hose routing.

FUEL VAPOR CANISTER

Remove or Disconnect

1. Electrical connector.
2. Hoses from fuel vapor canister.
3. Attaching screws (2).
4. Fuel vapor canister.
5. Retaining clips.

Install or Connect

1. Retaining clips.
2. Fuel vapor canister as removed.
3. Attaching screws (2).

Tighten

- Fuel vapor canister attaching screws 3 N·m (27 lb. in.).

4. Hoses.
5. Electrical connector.

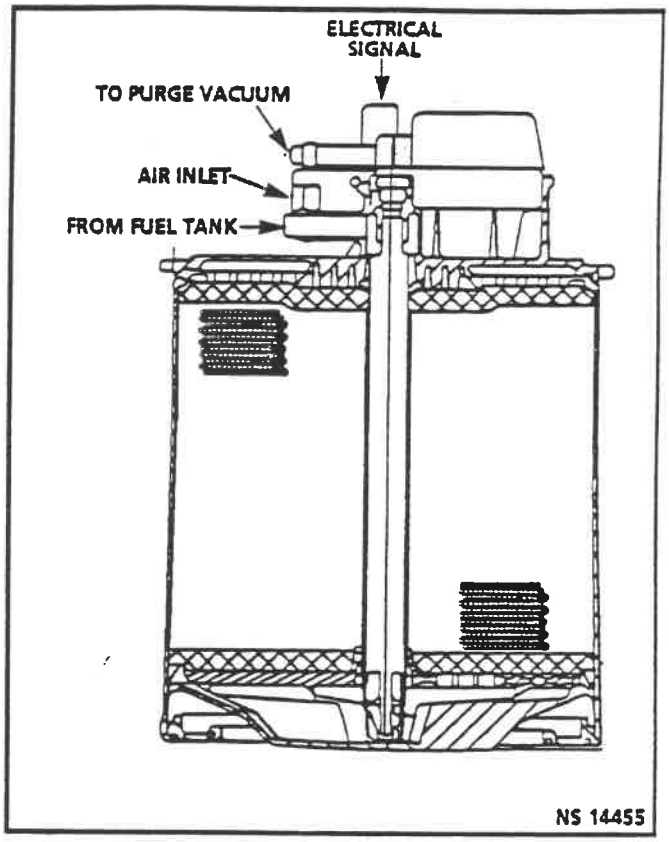
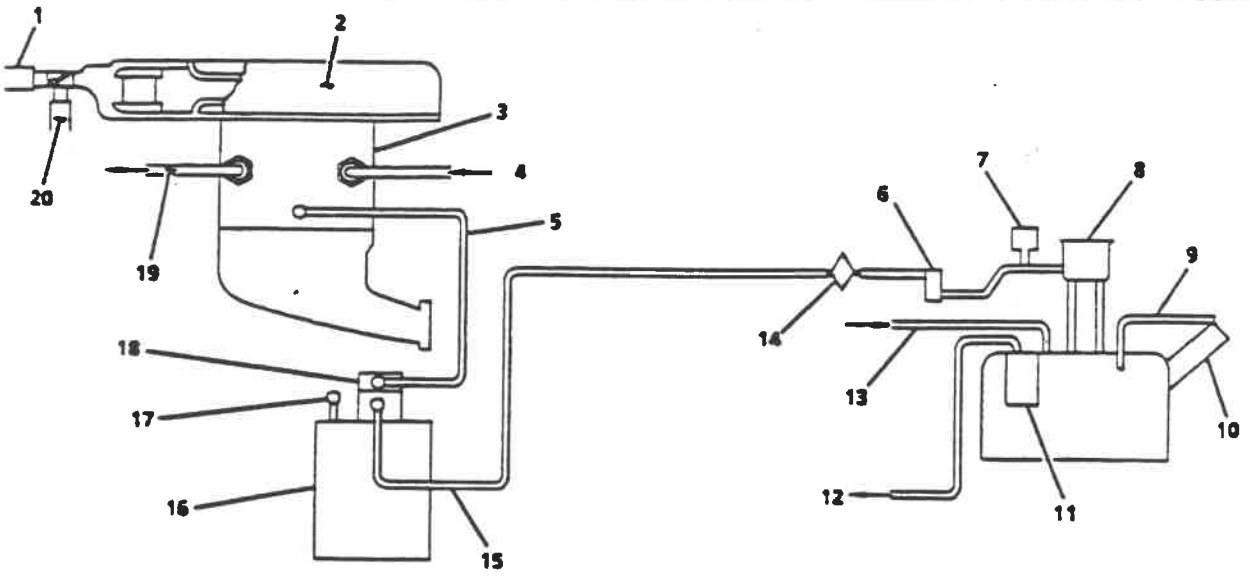


Figure 3.3-1 Vapor Canister

FUEL VAPOR CANISTER HOSES

Refer to "Vehicle Emission Control Information" label for routing of fuel vapor canister hoses.



1 COLD AIR INTAKE
2 AIR FILTER
3 THROTTLE BODY INJECTION UNIT
4 FUEL SUPPLY
5 CANISTER PURGE
6 ROLL OVER FUEL SHUT OFF VALVE
7 TANK PRESSURE RELIEF VALVE
8 SEPARATOR
9 AIR OUTLET PIPE
10 FILL PIPE
11 ELECTRIC FUEL PUMP
12 FUEL INLET TO THROTTLE BODY INJECTION UNIT
13 FUEL RETURN FROM THROTTLE BODY INJECTION UNIT
14 TANK PRESSURE CONTROL VALVE
15 FUEL TANK VENT TO CANISTER
16 CANISTER
17 FRESH AIR IN
18 CANISTER ELECTRONIC VALVE
19 FUEL RETURN
20 HOT AIR INTAKE

NS 14449

Figure 3.3-2 Evaporative Emission Control System

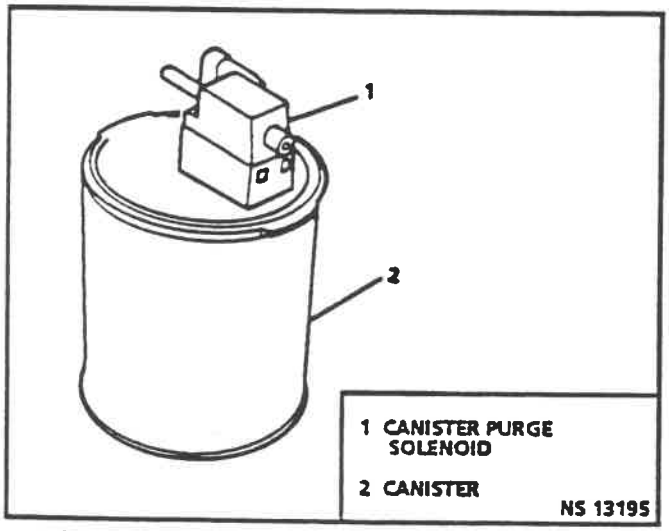


Figure 3.3-3 Canister Purge Solenoid - Removal

3.4 DIRECT IGNITION SYSTEM

ON-VEHICLE SERVICE

DIRECT IGNITION SYSTEM ASSEMBLY
Figures 3.4-1 and 3.4-2

Remove or Disconnect

1. Negative battery cable.
2. Direct ignition system electrical connectors, including harness ground terminals from bracket.
3. Spark plug wires. (Note proper relationship of wires to coils.)
4. Direct ignition system assembly to engine bolts (3).
5. Direct ignition system assembly from engine.

Install or Connect

1. Direct ignition system assembly to engine.
2. Direct ignition system assembly to block bolts(3).

Tighten

- Torque to 20-30 N·m (15-22 lb. ft.).

3. Spark plug wires to proper coils.
4. Direct ignition system electrical connectors harness ground terminals.
5. Negative battery cable.

IGNITION COIL

Remove or Disconnect

1. Coil retaining screws (2 per coil).
2. Coil from module.

Install or Connect

1. Coil to module.
2. Coil retaining screws.

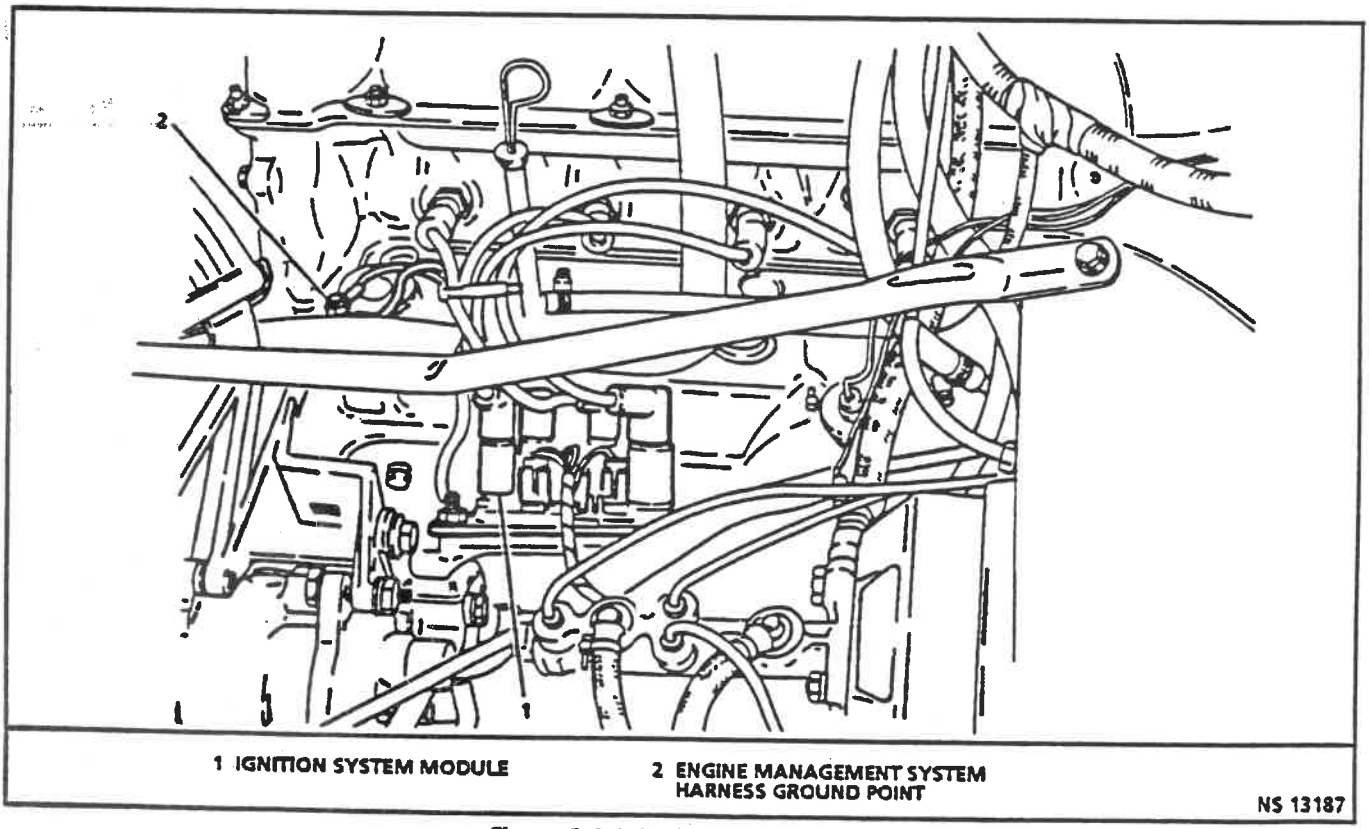
Tighten

- Torque to 4.5 N·m (40 lb. in.).

IGNITION MODULE

Remove or Disconnect

1. Negative battery cable.
2. Direct ignition system assembly from engine. (See previous procedure.)
3. Coils from assembly. (See previous procedure.)
4. Module from assembly plate.



1 IGNITION SYSTEM MODULE
2 ENGINE MANAGEMENT SYSTEM HARNESS GROUND POINT
NS 13187

Figure 3.4-1 Ignition Components

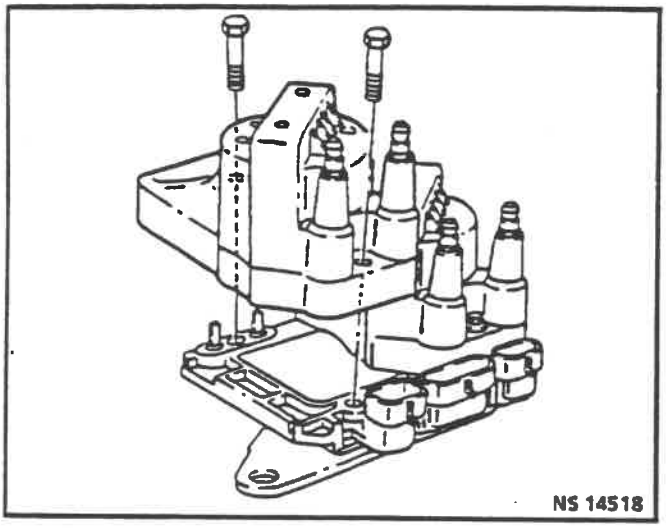


Figure 3.4-2 Direct Ignition System Coil Removal

Install or Connect

1. Module to assembly plate.
2. Coils. (See previous procedure.)
3. Direct ignition system assembly to engine. (See previous procedure.)
4. Negative battery cable.

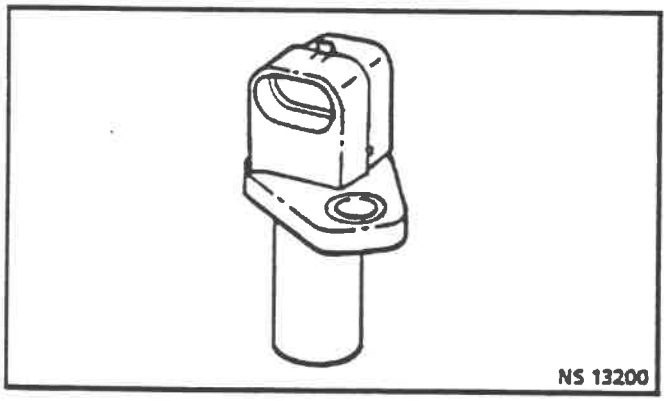


Figure 3.4-3 Crankshaft Sensor

CRANKSHAFT SENSOR

Figures 3.4-3 and 3.4-4

Remove or Disconnect

1. Sensor harness connector at module.
2. Sensor to block bolt (1).
3. Sensor from engine.

Inspect

- Sensor O-ring for wear, cracks or leakage. Replace if necessary. Lube new O-ring with engine oil before installing.

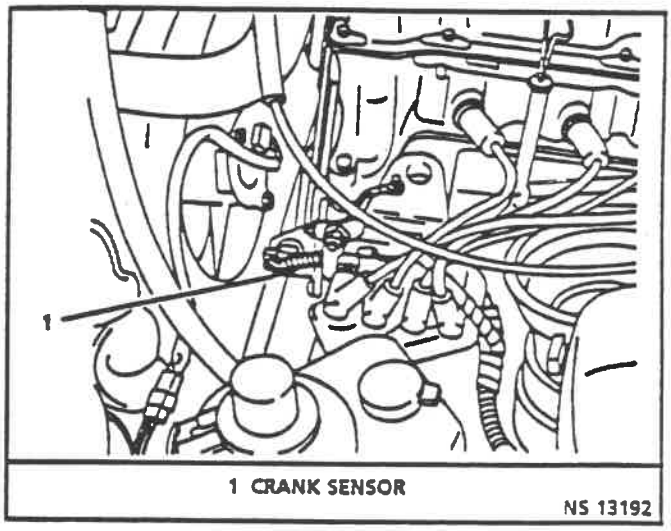


Figure 3.4-4 Crankshaft Sensor Location View

Install or Connect

1. Sensor into hold in block.
2. Sensor to block bolt (1).

Tighten

- Torque to 6-12 N·m (53-107 lb. in.).

3. Sensor harness connector at module.

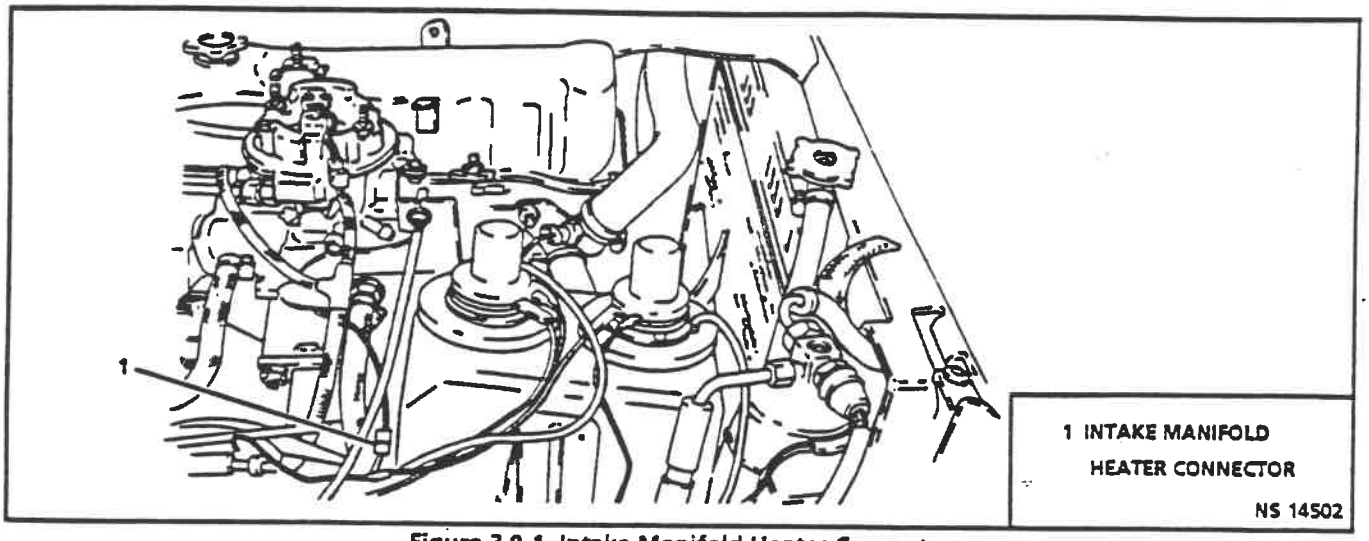


Figure 3.9-1 Intake Manifold Heater Connector

3.9 INTAKE MANIFOLD HEATER

ON-VEHICLE SERVICE

INTAKE MANIFOLD HEATER ASSEMBLY
Figures 3.9-1 and 3.9-2

Remove or Disconnect

1. Negative battery cable.
2. Intake manifold heater connector (Figure 3.9-1).
3. (3) manifold heater to intake manifold connecting bolts.
4. Intake manifold heater and gasket from underside of intake manifold (Figure 3.9-2).

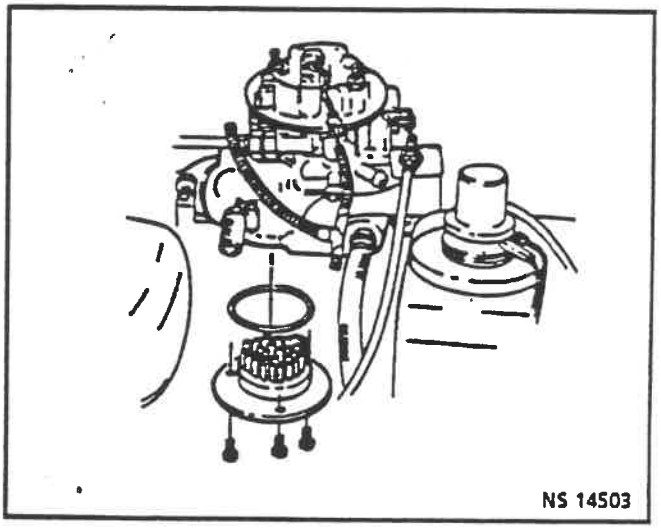


Figure 3.9-2 Intake Manifold Heater Removal

Important

- Inspect gasket for cracks or tears. Replace if necessary.

Install or Connect

1. Intake manifold heater and gasket to intake manifold.
2. (3) manifold heater to intake manifold connecting bolts.
3. Intake manifold heater connector.
4. Negative battery cable.

BLANK

4. SPECIFICATIONS

1.7L THROTTLE BODY INJECTION

IGNITION

CRANK SENSOR COIL RESISTANCE	500-700 OHMS
IGNITION COIL	
PRIMARY RESISTANCE	0.35-1.45 OHMS
SECONDARY RESISTANCE	5000-6500 OHMS
SECONDARY WIRE RESISTANCE	LESS THAN 15,000 OHMS

IGNITION TIMING IS CONTROLLED BY THE ELECTRONIC CONTROL MODULE AND IS NOT ADJUSTABLE.

FUEL

THROTTLE BODY INJECTION FUEL SYSTEM PRESSURE (WITH IGNITION "ON," ENGINE RUNNING)	190-210 kPa (27-30 psi; 1.9-2.1 bar)
THROTTLE BODY INJECTION FUEL INJECTOR RESISTANCE	1.42 TO 2.0Ω WHEN MEASURED BETWEEN 20°C and 50°C

IDLE SPEED IS CONTROLLED BY THE ELECTRONIC CONTROL MODULE. WHEN ENGINE IS WARM, IDLE SPEED SHOULD BE WITHIN 50 REVOLUTIONS PER MINUTE* OF DESIRED IDLE SPEED.

* SEE TECH 1 SCAN DATA VALUES.

BLANK

5. TORQUE SPECIFICATIONS

1.7L THROTTLE BODY INJECTION

TORQUE SPECIFICATIONS

THROTTLE BODY INJECTION ATTACH. BOLT/STUDS	17.0 N·m (12 lb. ft.)
FUEL LINE NUTS AT CONNECTION POINT TO THROTTLE BODY INJECTION ASSEMBLY	27.0 N·m (20 lb. ft.)
FUEL LINE NUTS AT FUEL FILTER	27.0 N·m (20 lb. ft.)
FUEL PRESSURE REGULATOR COVER	2.5 N·m (22 lb. in.)
FUEL METER BODY-THROTTLE BODY	6.0 N·m (53 lb. in.)
THROTTLE BODY INJECTION FUEL INLET NUT	27.0 N·m (20 lb. ft.)
THROTTLE BODY INJECTION FUEL OUTLET NUT	27.0 N·m (20 lb. ft.)
THROTTLE POSITION SENSOR	2.0 N·m (18 lb. in.)
IDLE AIR CONTROL VALVE	1.5 N·m (13 lb. in.)
TUBE MODULE ASSEMBLY	3.0 N·m (28 lb. in.)
INJECTOR RETAINER SCREW	3.0 N·m (28 lb. in.)
COOLANT TEMPERATURE SENSOR	14.0 N·m (10 lb. ft.)
INTAKE AIR TEMPERATURE SENSOR	14.0 N·m (10 lb. ft.)
SPARK PLUGS	15.0 N·m (11 lb. ft.)

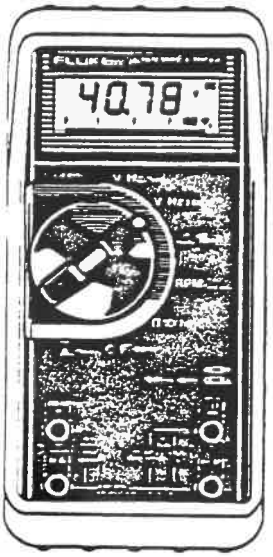
BLANK

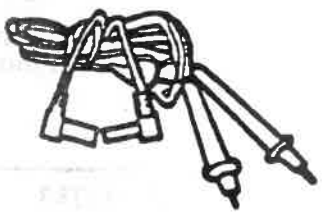
6. SPECIAL TOOLS

1.7L THROTTLE BODY INJECTION

Special diagnostic service tools that are mentioned in this service manual and described below are available for worldwide distribution from:

Kent-Moore
SPX Corporation
29784 Little Mack
Roseville, MI 48066-2298
1-800-345-2233
Monday through Friday
8:00 a.m. through 8:00 p.m. EST
Telex: 244040 KMTR UR
Fax: ~~313~~-578-7375
1-800





DIGITAL MULTIMETER

J 39689-78

VOLTMETER—Voltage position V measures magnitude of voltage when connected in parallel to an existing circuit. A digital voltmeter with a 10 megohm input impedance is used because this type of meter will not load down the circuit and result in faulty readings. Some circuits require accurate low resistance. Direct Current Voltage measurement selection V is used for most automotive measurements.

AMMETER—When used as an ammeter, this meter accurately measures extremely low current flow. Refer to meter instructions for more information.

- Selector must be set properly for both function and range. Direct Current measurement selection A is used for most automotive measurements.

OHMMETER—Measurement selection "Ω" measures resistance of circuit directly in ohms. Refer to meter instructions for more information.

- Overload display "OL" in all ranges indicates open circuit.
- Zero display in all ranges indicates a short circuit.
- An intermittent connection in a circuit may be indicated by a digital reading that will not stabilize on the circuit.

FREQUENCY—Position Hz measures frequency of AC or pulsed DC voltages.

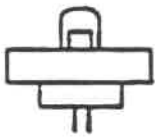
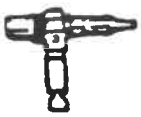
TEMPERATURE—Position °C °F, measures temperature using the included thermocouple probe.

DWELL-DUTY CYCLE—Position ∠° % measures dwell or duty cycle of pulse with modulated signals.

ENGINE SPEED—Position RPM measures engine speed. See meter sample for symbol.

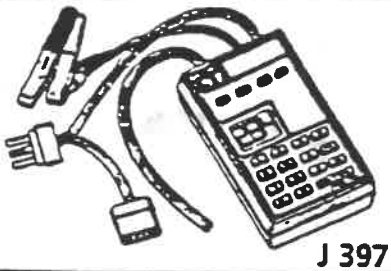
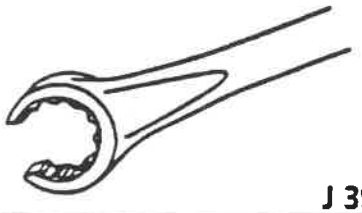
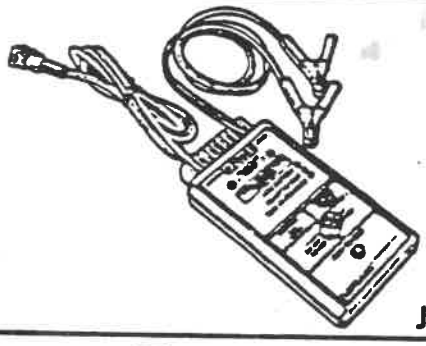
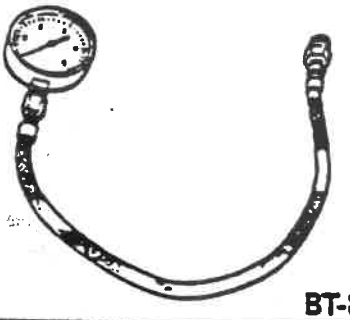
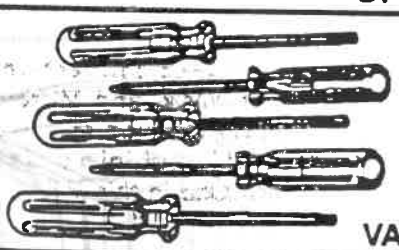
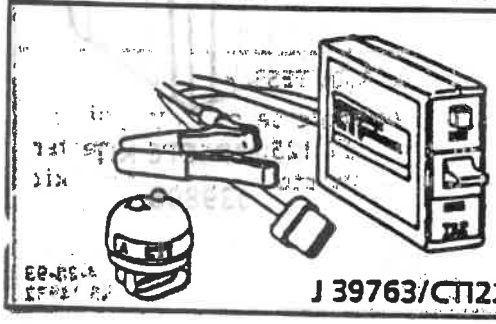
12-21-92
NS 14431

Special Tools (1 of 4)

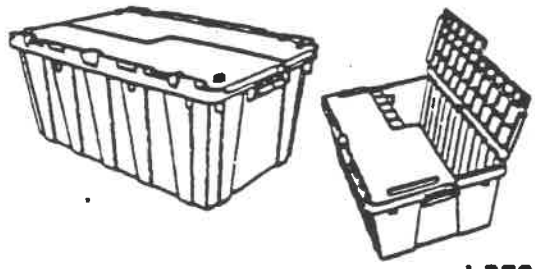
J 38970-V	**FUEL PRESSURE GAGE KIT** Used for checking and monitoring fuel line pressure of both throttle body fuel injection and port fuel injection. Includes one (1) Diagnostic Test fitting, needed to test the fuel pressure on the throttle body fuel injection system at the outlet fitting of the fuel filter.
 J 34730-2A	**INJECTOR CIRCUIT TEST LIGHT** Used for testing fuel injector circuits on both throttle body injection and port fuel injection systems. This is packaged in the J 35616-V connector test adapter kit.
	TECH 1 DIAGNOSTIC COMPUTER A hand-held scan tool used to analyze and diagnose fuel and emission system.
	TECH 1 VAZ TESTER CARTRIDGE The Tech 1 tester cartridge is a VAZ specific cartridge that allows the Tech 1 tool to test the VAZ fuel injection system.
J 35616-V	**CONNECTOR TEST ADAPTER KIT** Used for making electrical test connections in current Weather Pack, Metri-Pack, and Micro-Pack style terminals. The secondary ignition spark tester part number J 26792 (ST 125) and injector circuit test light J 34730-2A are included in this kit.
 J 26792	**SECONDARY IGNITION VOLTAGE TESTER** Used for checking available secondary ignition voltage. Also called an ST 125. This spark tester is packaged in the connector test adapter kit #J 35616-V.

4-28-93
NS 14432

Special Tools (2 of 4)

 J 39764/CTI234	**MANIFOLD ABSOLUTE PRESSURE SENSOR TESTER** Allows accurate testing of the manifold absolute pressure sensor. The tester compares the output voltage signal of the vehicle sensor to the tool's own calibrated standard sensor.
 J 39194-V	**EXHAUST OXYGEN SENSOR WRENCH** Used to remove and install the oxygen sensor which is used on this system.
 J 39021-V	**FUEL INJECTOR TESTER KIT** Connector harness adapters from twist lock connector to : • Throttle Body Injector, 700 Injector (J 39021-30) • Port Fuel Injector (J 39021-20) • Injector Switch Box (J 39021-10), for testing Port Fuel Injectors without removal from VAZ Port Fuel Injection engines.
 BT-8515-V	**EXHAUST SYSTEM BACKPRESSURE TESTER** Used to test for plugged or restricted exhaust system components, particularly the catalytic converter.
 VA 70433	**TORX FASTENER REMOVAL/INSTALLATION KIT** Torx fastener removal/installation tool kit, for fuel system components.
 J 39763/CTI222DM	**IDLE AIR CONTROL SYSTEM MONITOR** Used to test idle air control motors for correct functioning and proper response to commands. 4-28-93 NS 14435

Special Tools (3 of 4)



J 35805

PLASTIC CONTAINER

Plastic container, lockable to contain all tools mentioned on the previous pages.

J 39745

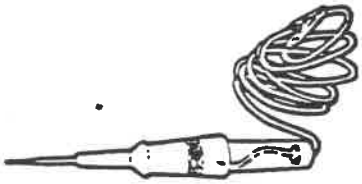
TERMINAL REPAIR KIT

Contains proper tools and components to perform reliable wiring repairs to the engine management system wiring harness.

J 35555

VACUUM PUMP WITH GAGE

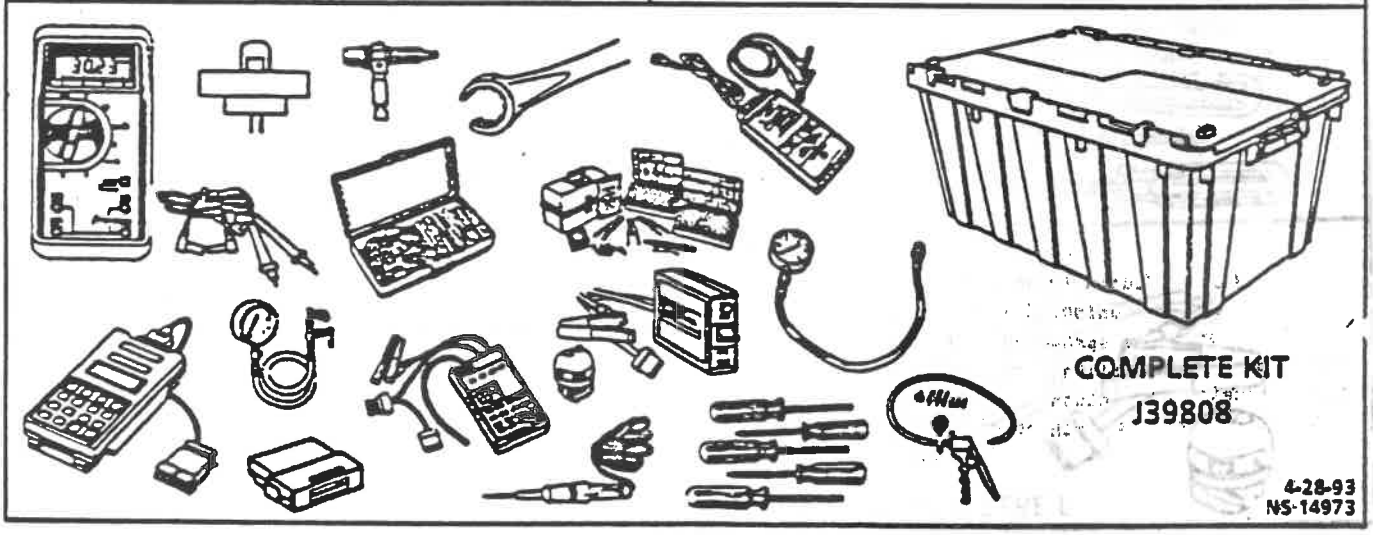
Use the gage to monitor manifold engine vacuum and use the hand pump to check vacuum sensors, solenoids and valves.



J 34142-B

UNPOWERED TEST LIGHT

Used in checking wiring for a complete circuit, short to ground, or voltage.



Special Tools (4 of 4)

Section III

POWER TRAIN

CLUTCH

The design of the clutch is illustrated in Fig.3-1. Clutch release yoke 11 (Fig.3-1) of two types can be used: with a flat spring or with a wire spring.

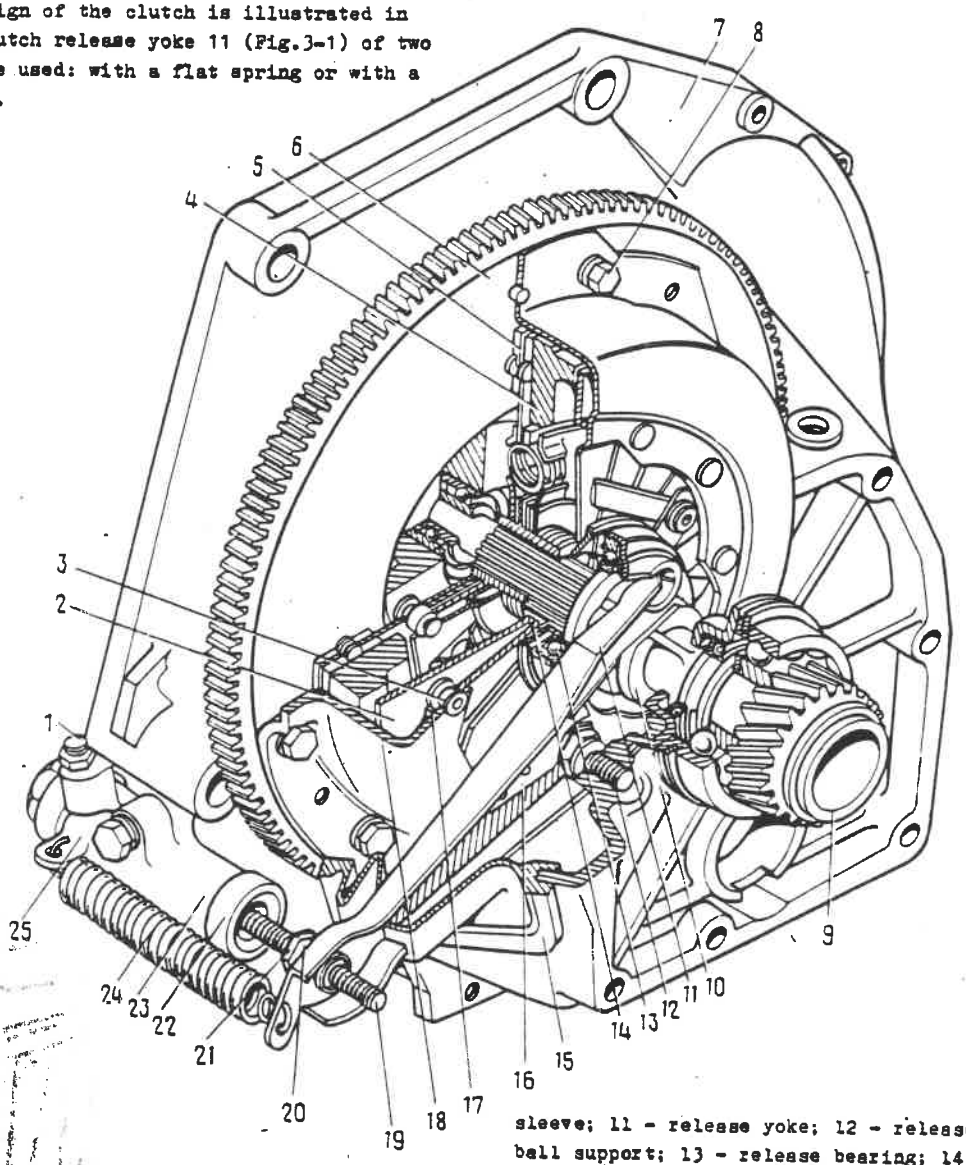


Fig.3-1. Clutch Assembly:
1 - bleeder union; 2 - central pressure spring; 3 - pressure spring stepped rivet; 4 - pressure plate; 5 - driven disc; 6 - flywheel; 7 - clutch housing; 8 - clutch cover-to-flywheel bolt; 9 - gearbox clutch shaft; 10 - clutch release sleeve; 11 - release yoke; 12 - release yoke ball support; 13 - release bearing; 14 - pressure spring thrust flange; 15 - release yoke cover; 16 - release yoke spring; 17 - pressure spring supporting ring; 18 - clutch cover; 19 - release yoke pushrod; 20 - adjusting nut; 21 - locknut; 22 - boot; 23 - clutch operating cylinder; 24 - release yoke pull-back spring; 25 - pull-back spring shackle

Trouble Shooting

Cause	Remedy
Clutch Drags	
1. Excessive clearances in clutch control mechanism	1. Adjust clutch control mechanism
2. Warpage of driven disc (face runout over 0.5 mm)	2. Straighten or replace disc
3. Roughness of driven disc facings	3. Replace facings or driven disc assembly
4. Loosening of rivets or breaking of driven disc facings	4. Replace facings, check end runout of disc
5. Jamming of driven disc hub on gearbox clutch shaft splines	5. Clean splines and coat them with grease ЛСЦ-15 or ФНОЛ-1, ФНОЛ-2У. If jamming is caused by mutilation or wear of splines, replace clutch shaft or driven disc
6. Breaking of plates connecting thrust flange with clutch cover	6. Replace clutch cover complete with pressure plate
7. Air in hydraulic system	7. Bleed hydraulic system
8. Fluid leaks from joints or damaged pipes of hydraulic system	8. Tighten joints, replace damaged parts, bleed hydraulic system
9. Fluid leaks from master or operating cylinder	9. Replace sealing rings, bleed system
10. Clogging of hole in reservoir cover, which causes depression in master cylinder and infiltration of air into cylinder through seals	10. Clear up hole in reservoir cover, bleed hydraulic system
11. Poor tightness caused by soiling or wear of master cylinder front sealing ring	11. Clean sealing ring or replace, if worn
12. Warpage or skewness of pressure plate	12. Replace clutch cover complete with pressure plate
Clutch Slips	
1. No clearances in clutch control mechanism	1. Adjust clutch control mechanism
2. Heavy wear or burning of driven disc facings	2. Replace friction facings or driven disc assembly
3. Oiling of driven disc facings, flywheel and pressure plate surfaces	3. Wash oiled surfaces carefully with white spirit, eliminate causes of oiling

Continued

Cause	Remedy
4. Clogging of master cylinder compensating hole	4. Wash cylinder, clear up compensating hole
5. Clutch control mechanism damaged or jammed	5. Eliminate faults that cause jamming
Jerky Engagement of Clutch	
1. Driven disc hub seized on clutch shaft splines	1. Clean splines, lubricate them with ЛСЦ-15 or ФНОЛ-1, ФНОЛ-2 grease. If seizure is caused by mutilation or wear of splines, replace clutch shaft or driven disc
2. Oiling of driven disc facings, flywheel and pressure plate surfaces	2. Wash oiled surfaces carefully with white spirit and eliminate cause of oiling
3. Jamming in clutch control mechanism	3. Replace distorted parts. Eliminate causes of jamming
4. Heavy wear of driven disc friction facings	4. Replace facings with new ones, check condition of disc surfaces
5. Loosening of driven disc facing rivets	5. Replace faulty rivets and, if necessary, facings
6. Pressure plate warped or its surfaces damaged	6. Replace clutch cover complete with pressure plate
Noisy Clutch Disengagement	
1. Wear, damage, or lubricant leaks from clutch release bearing	1. Replace bearing
2. Wear of gearbox clutch shaft front bearing	2. Replace bearing
Noisy Clutch Engagement	
1. Breaking or loss of resilience of driven disc damper springs	1. Replace driven disc assembly
2. Clutch release yoke return spring broken, lost its resilience or came off its hook	2. Fasten spring as required or replace by new one
3. Breaking of plates connecting pressure plate with cover	3. Replace clutch cover complete with pressure plate

Adjusting Clutch Control Mechanism

To adjust the clutch control mechanism perform the following operations:

- set a clearance of 0.1 - 0.5 mm between the pushrod and piston of the master cylinder (Fig.3-2). This clearance, required for a complete release of the clutch, is adjusted by clutch pedal stop 5.

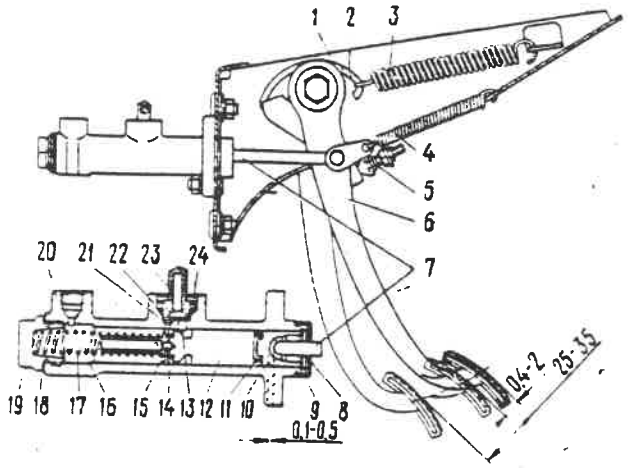


Fig.3-2. Clutch Pedal and Master Cylinder:
1 - clutch and brake pedal bracket; 2 - hook; 3 - clutch servo spring; 4 - clutch pedal retracting spring; 5 - clutch pedal stop; 6 - clutch pedal; 7 - pushrod; 8 - boot; 9 - lock ring; 10 - pushrod piston; 11 - sealing ring; 12 - master cylinder piston; 13 - inlet hole; 14 - sealing ring (circular valve); 15 - piston bypass hole; 16 - cylinder working chamber; 17 - piston return spring; 18 - gasket; 19 - plug; 20 - master cylinder barrel; 21 - bypass (compensating) hole; 22 - union gasket; 23 - union; 24 - lock washer

The clearance is determined by free travel of the pedal equal to 0.4 - 2 mm;

- adjust free travel of the operating cylinder pushrod (4 to 5 mm) with nut 5 (Fig.3-3) which is fixed by locknut 6. Free travel of the pushrod is checked with a special templet.

On completion of these adjustments, free travel of the clutch pedal (before the commencement of disengagement) should be 25 to 35 mm.

Bleeding Clutch Hydraulic System

Penetration of air into the clutch hydraulic system can be diagnosed by incomplete disengagement of the clutch as well as by a "spongy" or "sinking" pedal.

To bleed the hydraulic system:

- clean the reservoir and the bleeder union of dust and dirt;
- check fluid level in the hydraulic reservoir and top up, if necessary;
- put a hose on the head of operating cylinder bleeder union 9 (Fig.3-3) and dip its other end into a vessel with the brake fluid (30 - 50 g);
- turn off bleeder union 9 through 1/2 - 3/4 of a revolution; depress the pedal sharply and release it smoothly until air bubbles cease to emerge from the hose;
- depress the pedal and screw the union all the way on. Take off the hose and put the union boot in place.

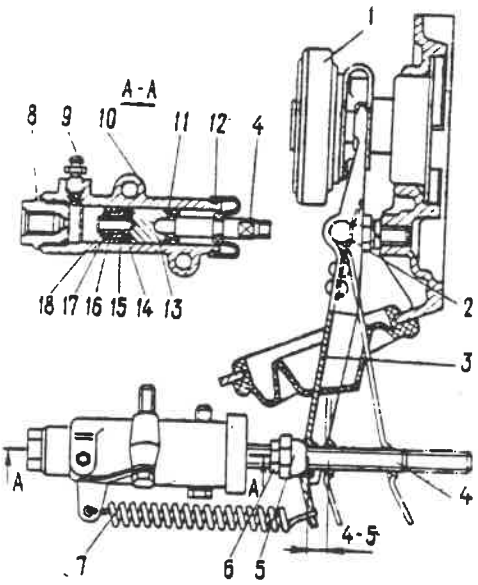


Fig.3-3. Clutch Operating Cylinder and Release Yoke:
1 - clutch release bearing; 2 - ball support; 3 - release yoke; 4 - pushrod; 5 - adjusting nut; 6 - locknut; 7 - retracting spring; 8 - barrel plug; 9 - bleeder union; 10 - cylinder barrel; 11 - sealing ring; 12 - boot; 13 - piston; 14 - seal; 15 - plate; 16 - spring; 17 - supporting washer; 18 - lock ring

If air bubbles continue to emerge from the hose after prolonged bleeding, check the joints for tightness and examine the pipes for cracks or air inleakage through the joints with the unions. Air may penetrate through faulty sealing rings of the master or operating cylinders.

When bleeding, observe the following requirements:

- fluid level in the reservoir should be above the hole of the pipe leading to the master cylinder;
- the end of the bleeder hose should be constantly immersed in fluid.

After bleeding, bring the fluid level in the reservoir to the lower edge of the filler throat.

Removal and Installation of Clutch

Removal. First remove the gearbox (see "Gearbox"). Unscrew the bolts and take off the clutch cover complete with the pressure plate. Do not lift this unit by gripping the thrust flange of the pressure spring.

Installation of the clutch is effected in reverse order, observing the following requirements:

- examine the bearing in the end of the engine crankshaft and replace it, if necessary;

- examine the splines in the driven disc hub and on the gearbox-clutch shaft, clean the splines and coat them with a thin layer of grease ЛСЦ-15 or ФИОЛ-1, ФИОЛ-2;

- position the protruding part of the driven disc hub with the circular groove facing the gearbox and align the disc relative to the bearing with the aid of mandrel A.70081 which imitates the splined end of the gearbox clutch shaft (Fig.3-4).

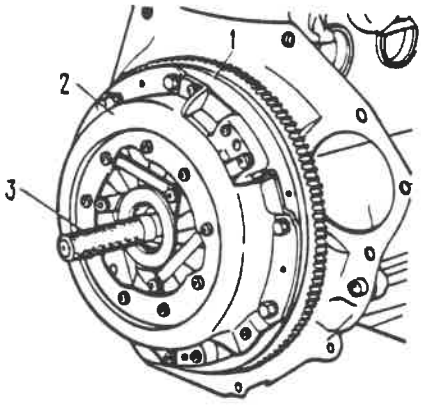


Fig.3-4. Aligning Driven Disc by Mandrel A.70081:
1 - flywheel; 2 - clutch assembly; 3 - mandrel A.70081

Clutch Checks

The clutch must be inspected and checked on a base plate shaped like the engine flywheel and provided with metal spacer ring 4 (8.2 mm thick) instead of the driven disc (Fig.3-5). Secure the clutch cover and make four release strokes, through 8-9 mm. A 8-mm release stroke should correspond to 1.6 - 1.7 mm travel of the pressure plate (the minimum permissible travel being 1.4 mm).

The distance from the base plate to the working surfaces of the friction ring on the thrust flange should be 40 - 43 mm. In the course of service this distance is apt to grow due to the wear of clutch disks. As soon as it reaches 48 mm or the pressure plate travel becomes smaller than 1.4 mm, the clutch cover must be replaced complete with the pressure plate.

Replace the friction facings of the driven disc if they become cracked, scored on one side or when the distance between the rivet and the working surface has diminished to 0.2 mm. During repairs of the driven disc and replacement of the friction facings use tool 67.7822.9529 (Fig.3-6). The upset rivets must have no fractures. Runout of the working surface of the friction facings shall not exceed 0.5 mm. If it is larger, straighten out the disc (see Fig.3-7) or replace it by a new one. If the driven disc or damper springs become cracked, replace the driven disc assembly.

Removal and Installation of Clutch Operating and Master Cylinders

The first thing to do is to drain the hydraulic fluid. For this purpose, slip one end of the hose on bleeder union 9 (Fig.3-3) of the operating cylinder, dip its other end into a clean vessel, unscrew union 9 through 1/2 - 3/4 of a revolution and keep pressing the pedal until all fluid is drained from the hydraulic system. Then disconnect the pipes laid between the master and operating cylinders, disconnect retracting spring 7, remove the cotter pin from the end of the pushrod, unscrew two bolts which fasten the operating cylinder and remove the latter.

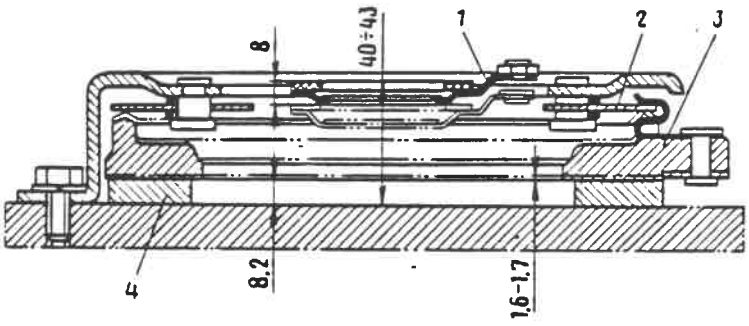


Fig.3-5. Clutch Checks:
1 - pressure spring thrust flange; 2 - central pressure spring; 3 - pressure plate; 4 - ring

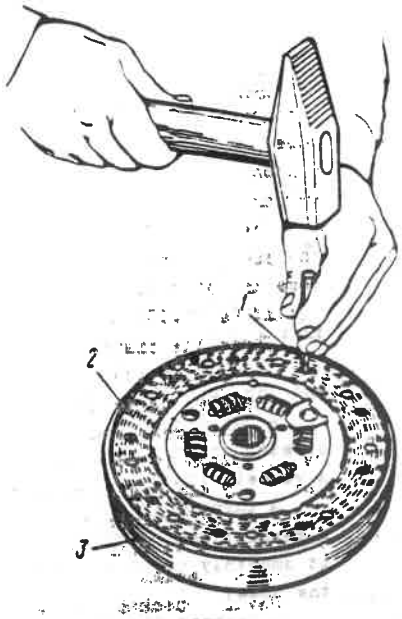


Fig.3-6. Replacing Driven Disc Friction Facings:
1 - mandrel 67.7851.9500; 2 - driven disc; 3 - jig 67.7822.9517

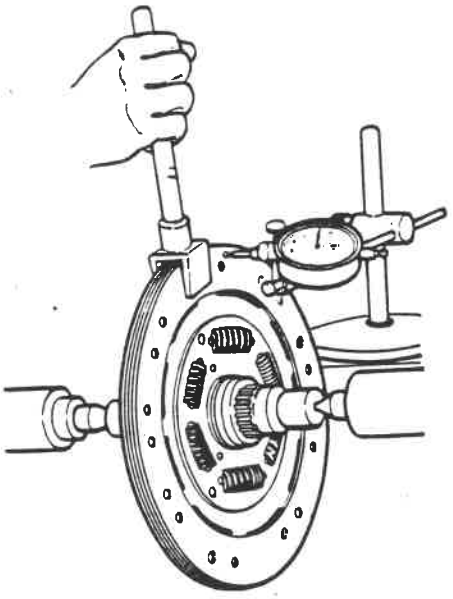


Fig.3-7. Straightening Clutch Driven Disc

To remove the master cylinder unscrew two nuts which fasten it on the pedal bracket studs and disconnect the flexible hose of the reservoir.

For installing the master and operating cylinders, reverse the above operations.

Fill the hydraulic system with fluid and bleed it.

Disassembly, Checking, Repair and Assembly of Master and Operating Cylinders

Master cylinder. Unscrew plug 3 (Fig.3-8), remove rubber boot 7 and lock ring 8. This makes it possible to take piston 9, sealing ring 10, floating piston 11 with sealing ring, and piston return spring 12 out of the cylinder barrel.

The cylinder face and the external surface of the piston must have no scores nor notches. The bore diameter of a serviceable master cylinder should be 19.035 - 19.075 mm.

Check the piston return spring and replace it, if it has lost its resilience.

Replace the sealing rings. Examine the rubber boot on the rear end of the cylinder and, if damaged, replace it by a new one. Before assembly, clean carefully and wash the parts with brake fluid. Keep mineral oil, gasoline, kerosene or diesel fuel away from the parts since these liquids cause swelling of rubber seals.

Having checked all parts, assemble the master cylinder by reversing the disassembly operations; lubricate the cylinder parts with brake fluid or preservative fluid НГ-213.

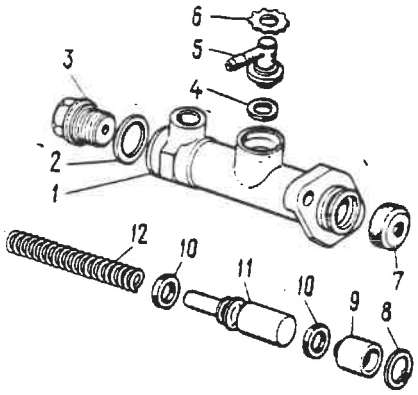


Fig.3-8. Master Cylinder Parts:
1 - barrel; 2 - sealing gasket; 3 - plug; 4 - gasket; 5 - union; 6 - lock washer; 7 - boot; 8 - lock ring; 9 - pushrod piston; 10 - sealing ring; 11 - master cylinder piston; 12 - spring

Operating cylinder. Unscrew the plug, remove rubber boot 3 (Fig.3-9) complete with pushrod 4, take out the piston and disassemble it, first having removed lock ring 11.

After disassembly, wash carefully and examine all parts as prescribed for the master cylinder. Discard the pushrod if it is distorted.

Having inspected the parts, assemble the cylinder (in the order reverse to disassembly), lubricating the parts with the hydraulic fluid.

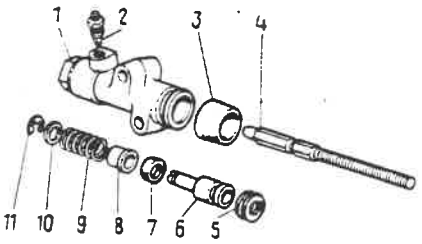


Fig.3-9. Clutch Operating Cylinder Parts:
1 - barrel; 2 - union; 3 - boot; 4 - pushrod; 5 - sealing ring; 6 - piston; 7 - sealing ring; 8 - spring seat; 9 - spring; 10 - washer; 11 - lock ring

Stand Checks of Clutch Master Cylinder

Tightness check of rear sealing ring. Put the master cylinder in the stand (Fig.3-10), ensuring efficient sealing of the joint between the cylinder flange and the mounting surface of the stand. Connect vessel 2 with hydraulic fluid to the cylinder. Open the compressed air cock with adjusting screw 6 turned off, then turn in this screw slowly until all air escapes from vessel 2.

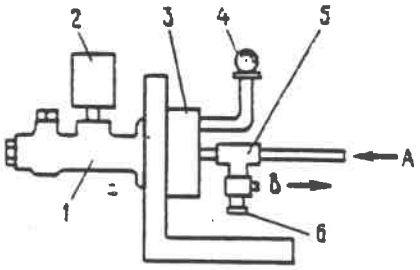


Fig.3-10. Checking Rear Sealing Ring for Tightness: 1 - master cylinder; 2 - vessel; 3 - adapter with seal; 4 - pressure gauge; 5 - tee-pipe; 6 - adjusting screw
A - air from compressor; B - air outlet

Watch the air pressure gauge; it should read from 0.05 to 0.08 MPa (0.5 to 0.8 kgf/cm^2). Replace the rear sealing ring, if the pressure is lower.

Tightness check of front sealing ring. Mount the master cylinder in the stand and connect it to a vessel filled with the hydraulic fluid and to pressure gauges (Fig.3-11).

Close the cock of pressure gauge 3 and, moving the pushrod of the master cylinder, set a steady pressure of 0.2 MPa (2 kgf/cm^2).

With the pushrod locked and no fluid leaks, the pressure should remain constant for 2 min.

Close the cock of pressure gauge 4 and open that of pressure gauge 3. Moving the pushrod, set a steady pressure of 10 MPa (100 kgf/cm^2), as read from the pressure gauge.

With the pushrod locked and no fluid leaks this pressure should remain constant for not less than 2 min. Otherwise, replace the front sealing ring.

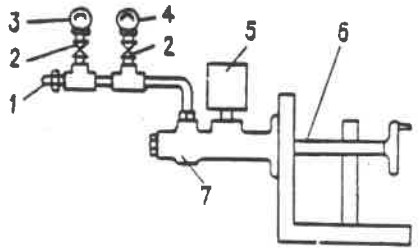


Fig.3-11. Checking Front Sealing Ring for Tightness: 1 - bleeder screw; 2 - cock; 3 - pressure gauge, division value 0.2 MPa (2 kgf/cm^2); 4 - pressure gauge, division value 0.005 MPa (0.05 kgf/cm^2); 5 - vessel; 6 - pushrod; 7 - master cylinder

GEARBOX

The design of the gearbox is illustrated in Figs 3-12, 3-26, 3-34.

Trouble Shooting

Cause	Remedy
Gearbox Noisy	
1. Noise in bearings	1. Replace faulty bearings
2. Wear of gear and synchronizer teeth	2. Replace worn parts
3. Low oil level in gearbox	3. Add oil. If necessary, eliminate cause of oil leakage
4. End play of shafts	4. Replace bearings or their fastening parts
Difficult Gearshifting	
1. Incomplete release of clutch	1. See under "Clutch"
2. Jamming of gearshift lever spherical joint	2. Dress mating surfaces of spherical joint
3. Deformation of gearshift lever	3. Eliminate deformation or replace lever by new one
4. Stiff movement of shift bars (burrs, soiling of bar seats, wedging of interlock retainers)	4. Repair or replace worn parts
5. Stiff movement of sliding sleeve on hub due to soiled splines	5. Clean parts

Continued

Cause	Remedy
6. Deformation of gearshift forks	6. Straighten out forks or replace them, if necessary
Uncontrollable Disengagement or Unreliable Engagement of Gears	
1. Wear of balls and shift bar seats, weakening of detent springs	1. Replace damaged parts by new ones
2. Wear of synchronizer baulk rings	2. Replace baulk rings
3. Breaking of synchronizer spring	3. Replace spring
4. Worn teeth of synchronizer sleeve or rim	4. Replace sleeve or gear rim
5. Mutilation of short teeth of synchronizer hub	5. Replace synchronizer hub
Leakage of Oil	
1. Wear of clutch shaft and main shaft glands	1. Replace glands
2. Loosening of gearbox housing covers, defective sealing gaskets	2. Tighten up nuts (for tightening torques see Appendix 1) or replace sealing gaskets
3. Loosening of clutch housing-to-gearbox housing fasteners	3. Tighten up nuts

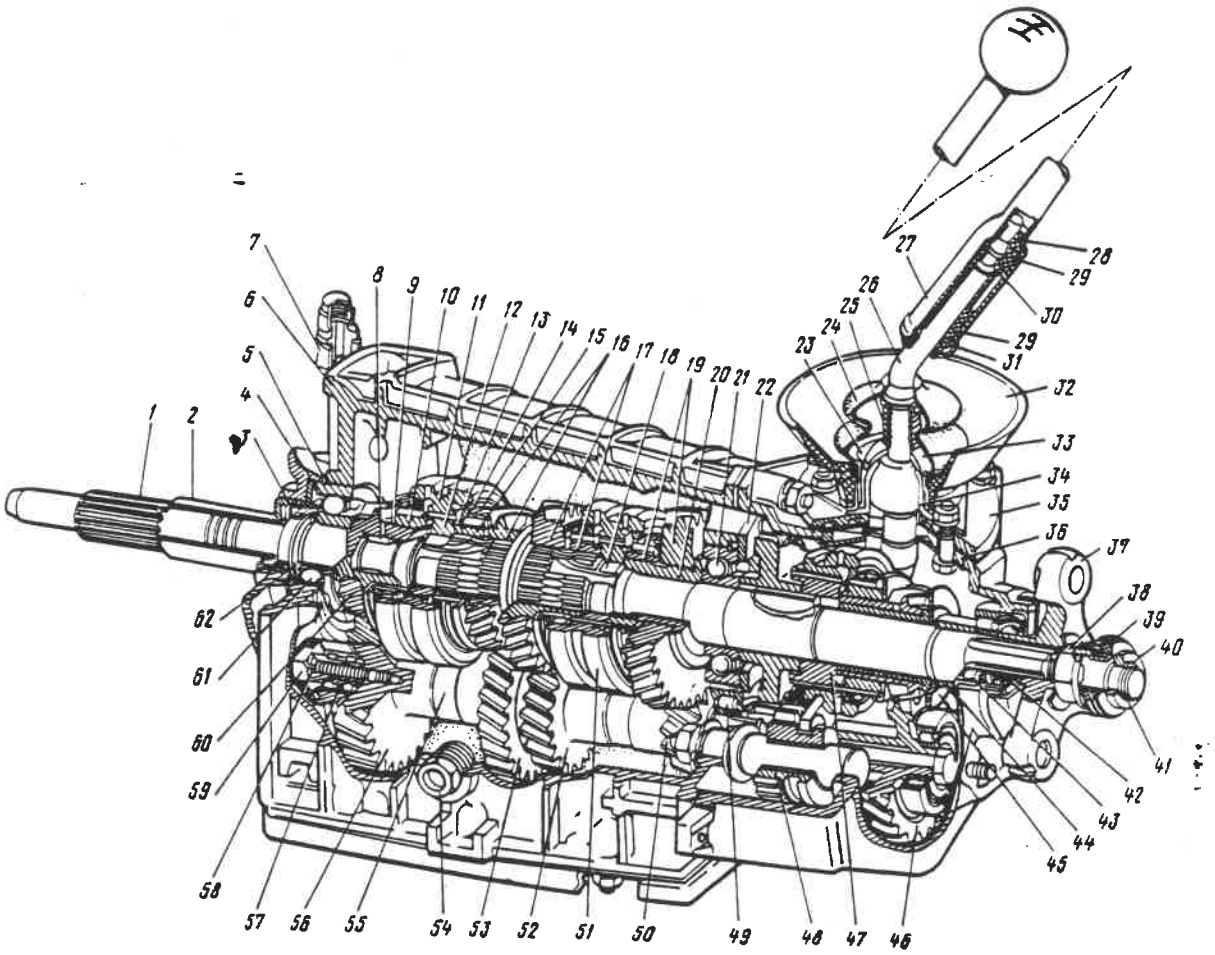


Fig.3-12. Gearbox:
1 - clutch shaft; 2 - front cover with guide bushing; 3 - clutch shaft gland; 4 - spring washer; 5 - bearing setting ring; 6 - gearbox housing; 7 - breather; 8 - main shaft needle bearing; 9 - synchronizer spring thrust washer; 10 - 4th speed synchronizer toothed rim; 11 - 3rd and 4th speed synchronizer sliding sleeve; 12 - 3rd and 4th speed synchronizer sliding sleeve hub; 13 - synchronizer locking ring; 14 - synchronizer baulk ring; 15 - synchronizer spring; 16 - 3rd speed synchronizer toothed rim and gear; 17 - 2nd speed synchronizer toothed rim and gear; 18 - main shaft; 19 - 1st speed synchronizer toothed rim and gear; 20 - 1st speed gear bushing; 21 - main shaft intermediate bearing; 22 - intermediate bearing locking plate; 23 - flange; 24 - boot; 25 - spring; 26 - gearshift lever; 27 - gearshift lever rod; 28 - damper flexible pad; 29 - damper rubber bushing; 30 - damper spacer bushing; 31 - damper lock bushing; 32 - cup; 33 - spherical washer; 34 - lever ball support; 35 - gearshift lever body; 36 - guide plate; 37 - propeller shaft flexible coupling flange; 38 - nut; 39 - aligning ring seal; 40 - aligning ring; 41 - retaining ring; 42 - main shaft rear bearing gland; 43 - main shaft rear bearing; 44 - spacer bushing; 45 - oil slinger washer; 46 - 5th speed and reverse gear cluster; 47 - 5th speed synchronizer hub; 48 - reverse idler gear; 49 - countershaft rear bearing; 50 - countershaft 1st speed gear; 51 - 1st and 2nd speed synchronizer sliding sleeve; 52 - countershaft 2nd speed gear; 53 - countershaft 3rd speed gear; 54 - filler and check hole plug; 55 - countershaft; 56 - countershaft constant-mesh gear; 57 - countershaft front bearing; 58 - countershaft bearing clamping washer; 59 - clamping washer bolt; 60 - clutch shaft constant mesh gear; 61 - clutch shaft rear bearing; 62 - retaining ring

Removal and Installation

Removal. Place the car on an inspection pit or a lift, put chocks under the front wheels and jack up the rear axle at one or both sides. Release the parking brake and set the gearshift lever in neutral. Disconnect the wires from the storage battery.

Remove the floor front mat and the outer boots of the gearbox and transfer case gearshift levers. Take off the lever hatch lids and the seals. Unscrew the knobs from the transfer case levers.

Press down lever shank 27 (Fig.3-12) and, using a screwdriver or some other sharp-pointed tool, pull locking bushing 31 out of its groove on the lever shank; remove the shank.

Disconnect the pipe and muffler mounts in the rear end of the car and detach the muffler pipe from the inlet pipe. Disconnect the clamp which holds the muffler inlet pipe to the exhaust manifold and move the pipe down and out of the car.

Unscrew the lower bolts of the clutch housing cover. Disconnect the "ground" wire from the clutch housing and the wires from the backing light switch.

Unhook retracting spring 1 from clutch release yoke 5 (Fig.3-13) and remove cotter pin 4 from pushrod 6. Disconnect operating cylinder 8 from the clutch housing. Cylinder 8 connected by a pipe with the master cylinder remains in the car, thus preventing losses of brake fluid and eliminating the need for subsequent bleeding of the clutch system.

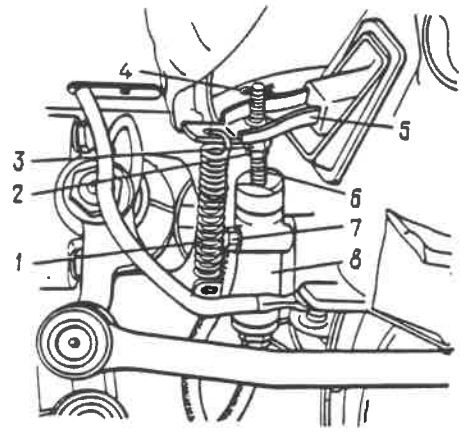


Fig.3-13. Clutch Control Linkage:
1 - yoke retracting spring; 2 - locknut; 3 - adjusting nut; 4 - cotter pin; 5 - clutch release yoke; 6 - pushrod; 7 - operating cylinder attachment bolt; 8 - clutch operating cylinder

Put clamp 2 (A.70025) on flexible coupling 3 (Fig.3-14) and tighten it. This will facilitate the removal and subsequent installation of the flexible coupling. Unscrew nuts 1 and, rotating the intermediate propeller shaft, take out the bolts which hold flexible coupling 3 to the flange of the gearbox main shaft.

Disconnect the speedometer flexible shaft from the speedometer drive on the transfer case.

Detach the flanges of the front and rear axle propeller shafts from the flanges of the transfer case shafts. Lower and shift aside the axle drive propeller shafts.

Unscrew the bolts that hold the transfer case brackets to the car and remove the transfer case complete with the propeller shaft.

Using articulated socket wrench 02.7812.9500, unscrew the bolts which fasten the starter to the clutch housing and detach the starter. Unscrew the bolts of the clutch housing cover.

Disconnect the support of the engine rear mount from cross member 4 (Fig.3-14) and remove the cross member, holding up the gearbox from underneath.

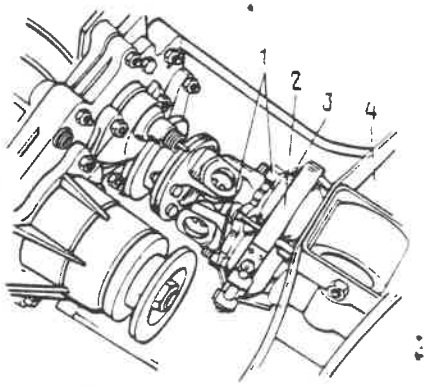


Fig.3-14. Propeller Shaft-to-Gearbox Flexible Coupling:
1 - propeller shaft-to-flexible coupling nuts; 2 - clamp A.70025; 3 - flexible coupling; 4 - engine rear mount crossmember

Place a jack, a trestle or another suitable support under the gearbox housing. Using articulated socket wrench A.55035, unscrew the bolts and remove the gearbox complete with the clutch housing by moving the unit towards the rear end of the car so as to withdraw the clutch shaft from the front bearing and from the clutch driven disc hub.

Caution:

When removing or installing the gearbox, DO NOT rest the end of the clutch shaft against the thrust flange of the clutch pressure spring to avoid distorting the clutch connecting plates.

Installation of the gearbox is carried out by reversing the removal operations. Before installation, apply a thin coat of ЛСЦ-15(Литол-24) grease to the splined end of the clutch shaft and align the clutch driven disc (see Fig.3-4) with mandrel A.70081.

Disassembly and Assembly

Disassembly. Wash the gearbox and install it on a stand. Drain oil and remove the lower cover with the gasket.

Take out the clutch release yoke. Remove the release sleeve complete with the bearing and connecting spring from the guide sleeve of the gearbox front cover.

Remove the clutch housing with the gasket and the front cover of the gearbox complete with the gland and spring washer (Fig.3-15).

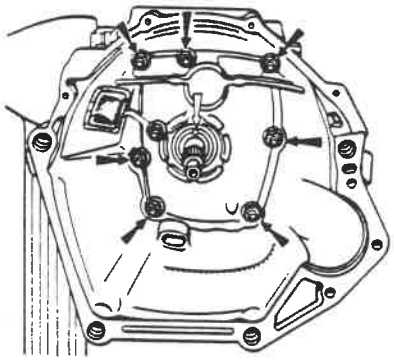


Fig.3-15. Clutch Housing Inside View. Black arrows show housing-to-gearbox nuts. White arrow shows hole in front cover for draining oil out of gearbox to prevent oiling of clutch discs

Turn out the backing light switch, taking care not to distort its body.

Unscrew the bolt of the 3rd and 4th speed shift fork. Put fixing tool 41.7816.4068 on the clutch shaft or engage two gears simultaneously. This will prevent rotation of the clutch shaft, main shaft and countershaft and facilitate subsequent disassembly operations.

Remove the ring from the end of the gearbox main shaft (Fig.3-16).

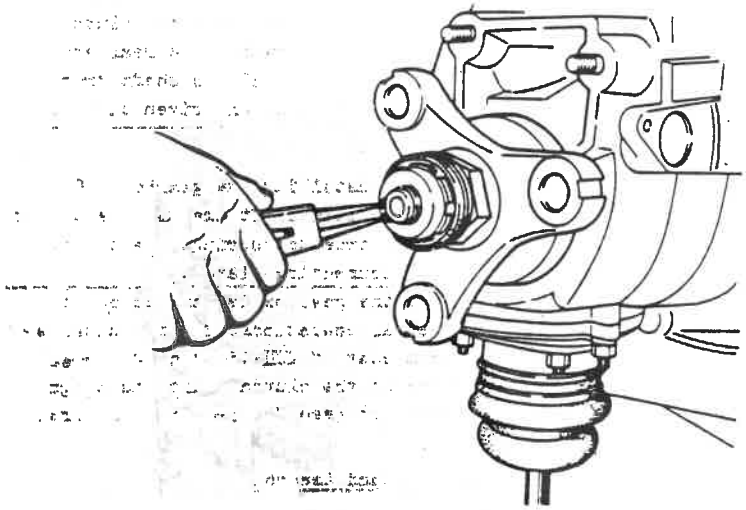


Fig.3-16. Removing Lock Ring

Unbend the lock washer, unscrew the nut a few revolutions so as to shift the aligning ring of the flexible coupling and screw on the nut again. Using pusher A.40006/1 with remover tool A.40005/4, take the aligning ring of the propeller shaft flexible coupling off the end of the main shaft (Fig.3-17).

Remove the seal of the flexible coupling aligning ring with the spring from the end of the main shaft, unscrew the nut and, using remover A.40005/3/9B/9C, take off the flexible coupling flange (Fig.3-18).

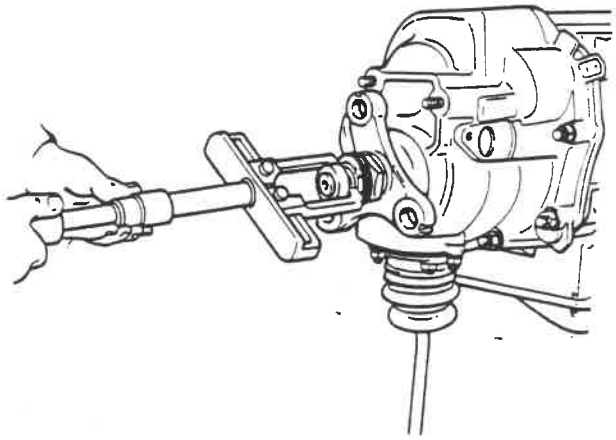


Fig.3-17. Removing Aligning Ring of Propeller Shaft Flexible Coupling

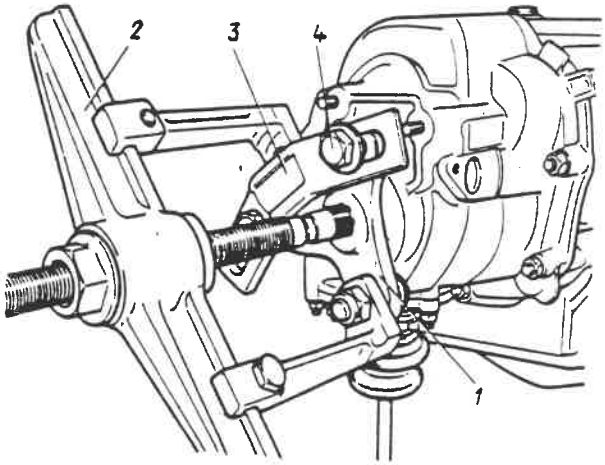


Fig.3-18. Removing Flexible Coupling Flange with Remover A.40005/3/9B/9C:
1 - flexible coupling flange; 2 - remover A.40005/3; 3 - fixture of remover A.40005/3; 4 - fixture-to-flange fastening bolts

Prior to removing the rear cover, shift the gearshift lever into neutral position, turn off the nuts holding the gearshift mechanism and remove the gearshift lever (Fig.3-19) complete with the gearshift mechanism. One of the cover attachment nuts is turned off from inside of the gearbox housing with the lower cover removed. When removing the rear cover, move it rearwards and turn to preclude brushing the reverse and 5th speed gear cluster.

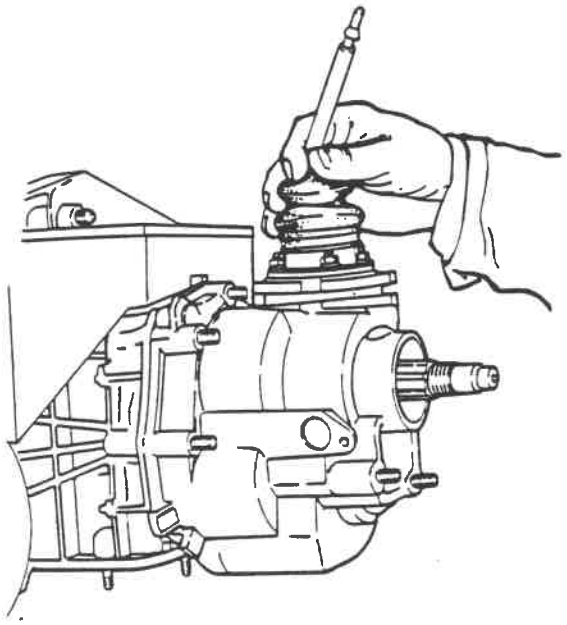


Fig.3-19. Removing Gearshift Lever and Mechanisms

Having removed the inner race of rear bearing 43 (Fig.3-12) and spacer bushing 44 of the bearing, back off the bolts holding cover 5 (Fig. 3-20) and turn out bolts 2 and 4 holding the gear cluster and 5th speed and reverse gear shift fork. Remove oil slinger washer 45 (Fig.3-12) and bushing 1 (Fig.3-21) of the 5th speed gear and take bar 1 (Fig.3-22) out of fork 2. Simultaneously remove spacer bushing 3 from the bar. Then take gear cluster 4 off the splines of the countershaft.

Simultaneously remove reverse idler gear 1 (Fig.3-23) from the axle, gear 3 complete with the sleeve and fork 4 from the main shaft.

Using the mandrels of screwdriver type remove 5th speed synchronizer hub 4 (Fig.3-24) and reverse driven gear 2 from the key.

Using the mandrels of screwdriver type and rod drifts take the front and rear bearings of the countershaft out of the gearbox housing. Make marks on the inner races of the double-row bearing to install the races in the initial position in the outer race of the bearing.

Take the countershaft out of the gearbox housing by tilting it as shown in Fig.3-25.

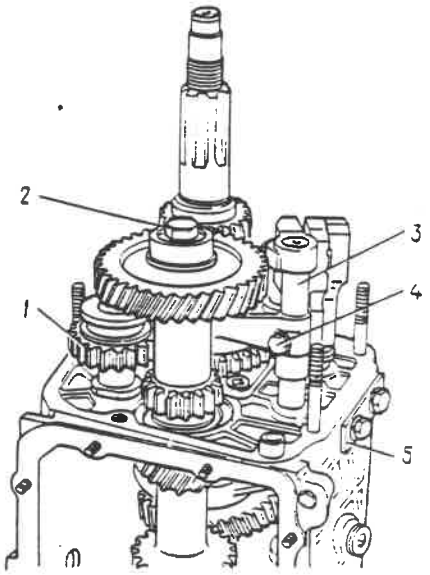


Fig.3-20. Turning Out Bolts Holding 5th Speed and Reverse Gear Cluster and Shift Fork:
1 - reverse idler gear; 2 - gear cluster attachment bolt; 3 - shift fork bar; 4 - fork attachment bolt; 5 - detent cover

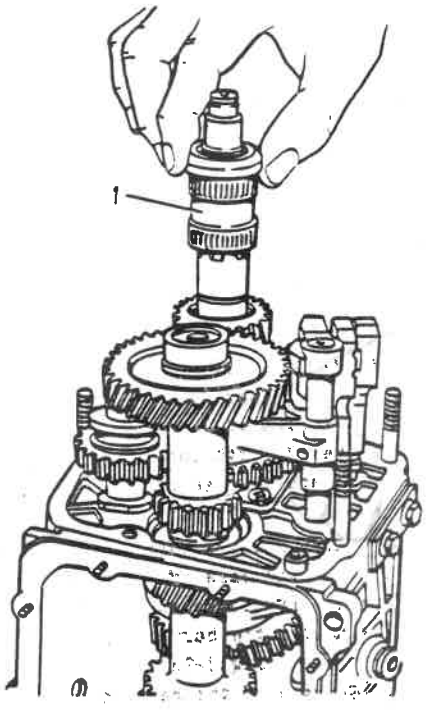


Fig.3-21. Removing 5th Speed Gear Bushing:
1 - bushing

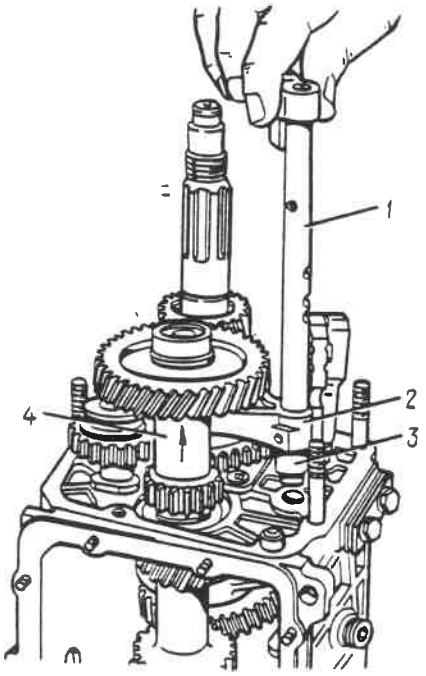


Fig.3-22. Removing 5th Speed and Reverse Shift Fork Bar:
1 - 5th speed and reverse shift fork bar; 2 - 5th speed and reverse shift fork; 3 - spacer bushing; 4 - gear cluster

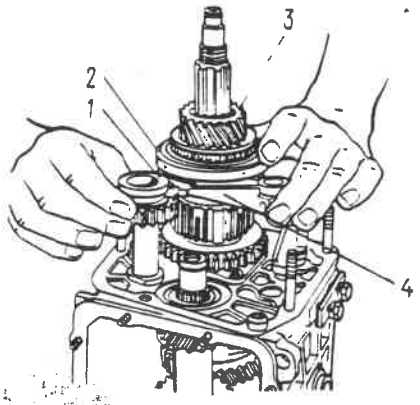


Fig.3-23. Removing Reverse Idler Gear, 5th Speed Gear Complete with Synchronizer and Fork:
1 - reverse idler gear; 2 - 5th speed engagement sleeve; 3 - 5th speed and reverse gear; 4 - 5th speed and reverse shift fork

Turn out the bolts holding the forks and take in turn the bars of the 1st, 2nd, 3rd and 4th speed shift forks out of the gearbox housing. When taking out the bars, remove three interlock retainers 6 (Fig.3-26). Remove the locking plate (Fig.3-27) of the main shaft intermediate bearing. Turn off the nut holding the reverse idler gear axle and remove the latter.

Using the mandrels of screwdriver type take out the clutch shaft complete with the bearing and synchronizer ring (Fig.3-28) and remove the needle bearing from the front end of the main shaft.

Knock the main shaft out of the intermediate bearing, and take out the intermediate bearing. By tilting the shaft as shown in Fig.3-29, take the main shaft complete with the gears, sleeves and synchronizer rings out of the housing. Remove the 3rd and 4th speed synchronizer sleeve from the shaft.

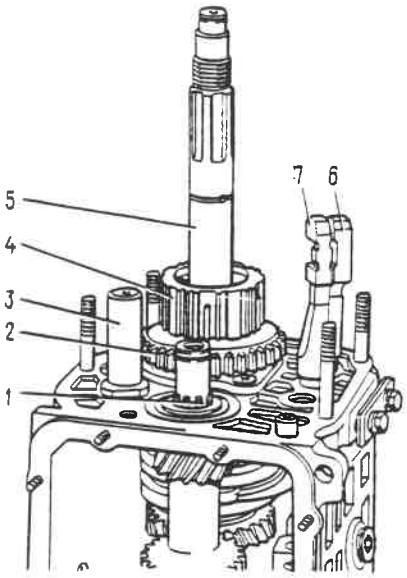


Fig.3-24. Removing Reverse Driven Gear and 5th Speed Synchronizer Sleeve Hub:
1 - countershaft; 2 - reverse driven gear; 3 - reverse idler gear axle; 4 - 5th speed synchronizer sleeve hub; 5 - main shaft; 6 - 1st and 2nd speed shift fork bar; 7 - 3rd and 4th speed shift fork bar

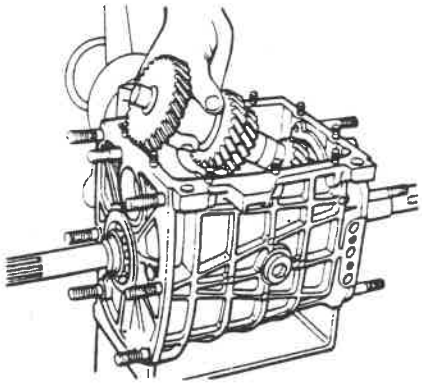


Fig.3-25. Removing Countershaft out of Gearbox Housing

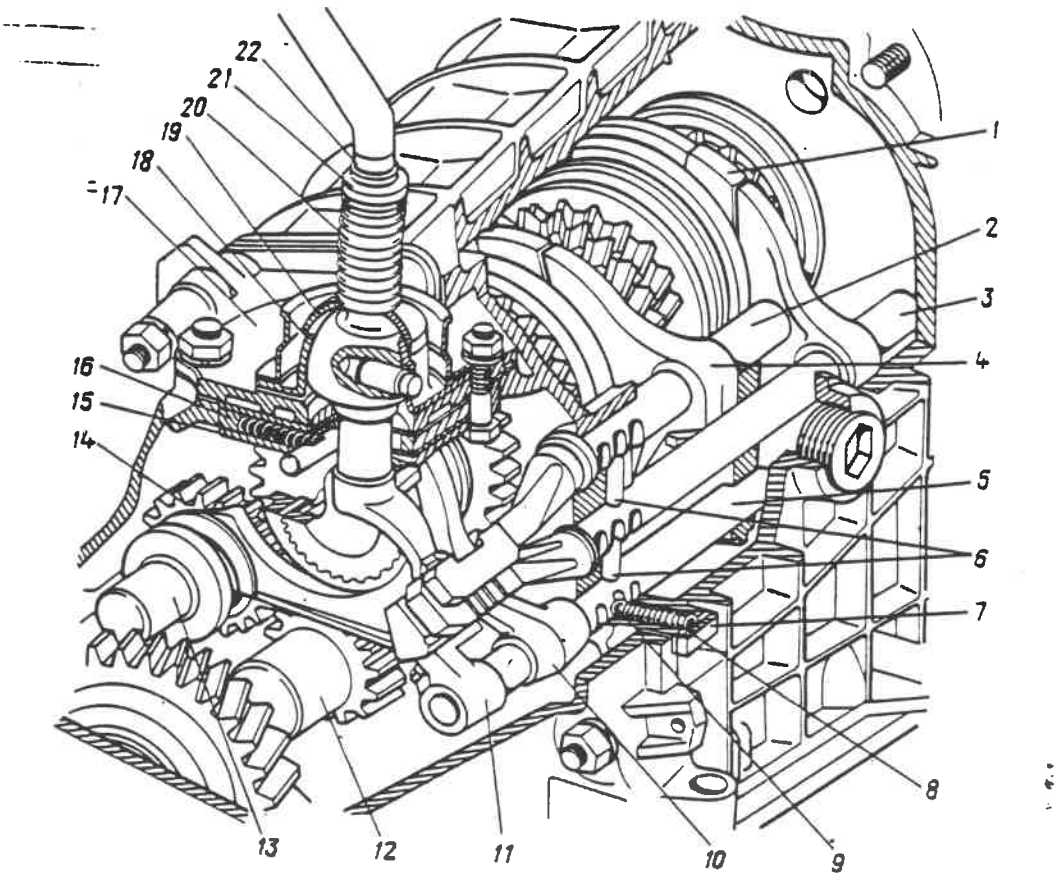


Fig.3-26. Gearbox Control Mechanism:
1 - 3rd and 4th speed shift fork; 2 - 1st and 2nd speed shift fork bar; 3 - 3rd and 4th speed shift fork bar; 4 - 1st and 2nd speed shift fork; 5 - 5th speed and reverse shift fork bar; 6 - interlock retainers; 7 - detent cover; 8 - detent spring; 9 - detent ball; 10 - 5th speed and reverse shift fork; 11 - 5th speed and reverse shift fork bar head; 12- 5th speed and reverse gear cluster; 13 - reverse idler gear axle; 14 - reverse idler gear; 15 - guide plate washer; 16 - guide plate; 17 - gearshift lever housing; 18 - ball support; 19 - spherical washer; 20 - spring; 21 - thrust washer; 22 - retaining ring

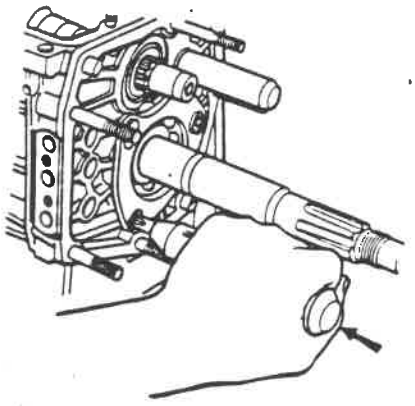


Fig.3-27. Removing Fastening Screws of Main Shaft Intermediate Bearing Locking Plate with Power Screwdriver. Arrow shows direction of impact stroke (when striking the screwdriver with a hammer)

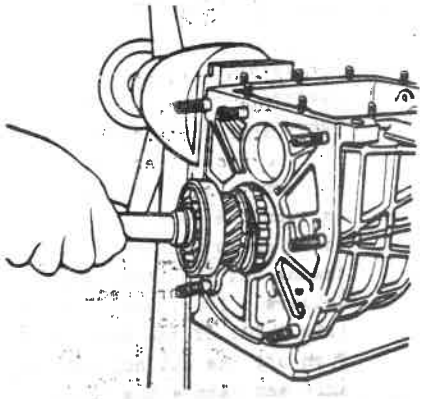


Fig.3-28. Removing Clutch Shaft out of Gearbox Housing

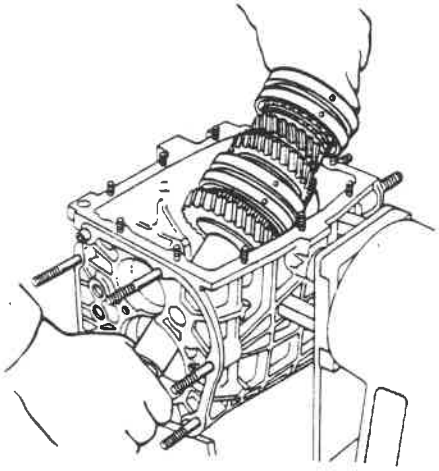


Fig.3-29. Removing Main Shaft out of Gearbox Housing

Disassemble the clutch shaft as follows:

- remove lock ring 7 (Fig.3-30), baulk ring 6 and spring 5 of the synchronizer;
- mount the shaft in a press and, compressing spring washer 2 with mandrel 41.7816.4069, remove lock ring 1, the spring washer and bearing 3.

Disassemble the main shaft (Fig.3-31) as follows:

- remove 1st speed gear 11 with bushing 12, hub 3 with 1st and 2nd speed sliding shift sleeve 4 and 2nd speed gear 10 complete with synchronizer baulk ring 5 from the rear end of the shaft;
- install the main shaft with mandrel 41.7816.4069 in a press (Fig.3-32), put supporting half-rings 3 under the 3rd speed gear and, pressing on the spring washer with the mandrel, remove lock ring 2; then remove spring washer 4, the hub of the 3rd and 4th speed sliding shift sleeve and the 3rd speed gear.

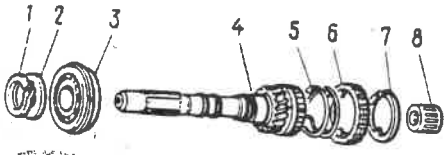


Fig.3-30. Clutch Shaft Parts:
1 - lock ring; 2 - spring washer; 3 - bearing; 4 - clutch shaft; 5 - synchronizer spring; 6 - synchronizer baulk ring; 7 - lock ring; 8 - bearing

If necessary, disassemble the gearshift lever and mechanism proceeding as follows:

- remove boot 10 (Fig.3-33), retaining and thrust rings 6 and 7, spring 5 and spherical washer 4 from the gearshift lever;
- note visually the position of the parts relative to notch A (Fig.3-34) on the guide plate to connect the parts in the initial position during the assembly;
- turn off the nuts of the attachment bolts, disconnect the parts of the gearshift mechanism and remove lever 9, its ball support 4 and rubber sealing rings 15.

Assembly. To assemble the gearbox reverse the disassembly operations. In doing so bear in mind that:

- the reverse idler gear axle should be fixed by applying a torque of 78 N.m (7.8 kgf.m) before installing the shafts in the gearbox housing;
- before installing the 5th speed and reverse shift fork bar in the housing, fit the spacer bushing on the bar;
- the inner race of the bearing should be press-fitted on the 5th speed and reverse gear cluster, and the outer race, in the rear cover seat;
- the main shaft rear bearing should be press-fitted onto the shaft to facilitate mounting the rear cover;
- reverse idler gear 1 (Fig.3-23), gear 3 and fork 4 should be installed simultaneously;
- when assembling the gearshift lever the ball head and sphere of the ball support should be coated with grease ЛСЦ-15 or Литол-24;
- the bolt holding the gear cluster should be tightened to a torque of 78 N.m (7.8 kgf.m);
- when installing the clutch housing with the gearbox front cover, the hole in the front cover should be arranged as shown in Fig.3-15;
- the active surfaces of the glands should be coated with grease Литол-24 before the installation;
- mandrels 41.7853.4028, 41.7853.4032 and 41.7853.4039 should be used for fitting the glands and bearings.

Inspection

Cleaning. Before inspection, clean the gearbox parts thoroughly. Remove all deposits with a brush or scraper and dislodge any dirt from holes and splines; then wash the parts so as to remove and dissolve any lubricant remnants.

Airblast the parts and wipe them carefully. Particular care should be exerted in airblasting the bearings. Direct the air jet so as to avoid rapid rotation of the bearing races.

Housing and covers. The housing should be free of cracks, and the bores for the bearings must be neither worn nor damaged.

The surfaces contacting the clutch housing, the rear and lower covers must be free of damage so as to prevent leakage of oil. Minor defects should be smoothed out with a file. Replace the parts with new ones if they are heavily damaged or worn.

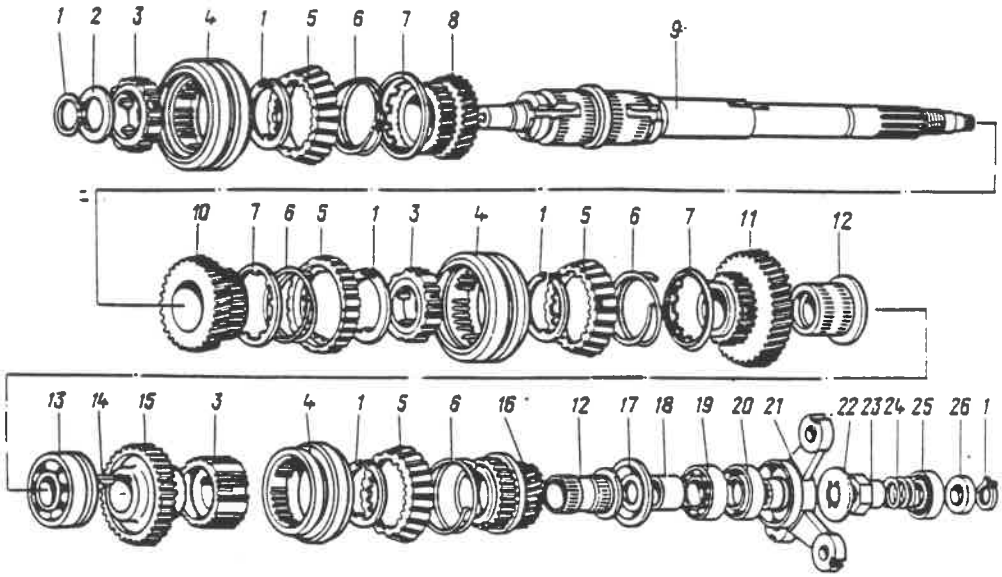


Fig.3-31. Main Shaft Parts:
1 - lock ring; 2 - spring washer; 3 - synchronizer hub; 4 - synchronizer sleeve; 5 - synchronizer baulk ring; 6 - synchronizer spring; 7 - washer; 8 - third speed gear; 9 - main shaft; 10 - second speed gear; 11 - first speed gear; 12 - gear bushing; 13 - bearing; 14 - key; 15 - reverse gear; 16 - fifth speed gear; 17 - oil deflecting washer; 18 - spacer bushing; 19 - main shaft rear bearing; 20 - gland; 21 - flexible coupling flange; 22 - lock washer; 23 - nut; 24 - seal spring; 25 - seal; 26 - slinging ring

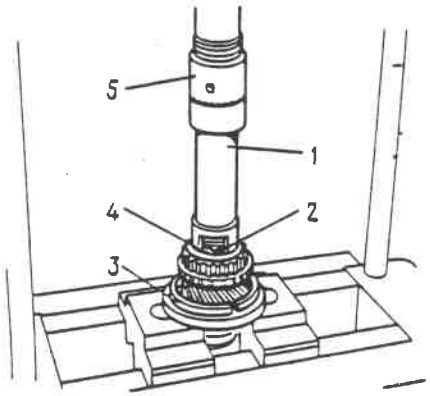


Fig.3-32. Installing Main Shaft Lock Ring:
1 - mandrel 41.7816.4069; 2 - lock ring; 3 - supporting half-ring; 4 - spring washer; 5 - press rod

Examine the front cover and check to see that the clutch shaft runs clear of the cover. If the shaft and cover are axially misaligned, replace the faulty parts. Check to see that the oil drain hole in the cover (shown by arrow in Fig.3-15) is not obstructed. Clean the drain plug.

Glands. Examine the glands and make sure their working edges are not damaged, worn out or irregular in shape.

Wear of the working edges in width should not be over 1 mm. Replace the glands no matter how slightly they are damaged.

Shafts. The working surfaces and splines of the main shaft must be neither damaged nor worn. The rolling surfaces of the needles on the front end of the shaft must not be rough nor scored.

Examine the rolling surfaces of the needles in the clutch shaft hole.

Inspect the countershaft; it must be free of chipping or excessive wear of teeth.

The axle of the reverse gear must be perfectly smooth and bear no signs of jamming. The assembly clearance between the axle and bushing of the reverse idler gear is 0.056 - 0.09 mm, the wear limit being 0.15 mm. Check this clearance by measuring the diameters of the gear axle and the hole in the gear bushing. The diameters of the new parts are as follows: gear axle - 19.079 - 19.094 mm, the inside diameter of the press-fitted bushing - 20.05 - 20.07 mm.

Minor roughness of the surfaces can be smoothed down with fine emery cloth. In case of serious damage and distortions, replace the shaft by a new one.

Gears. Gear teeth must not be damaged, nor excessively worn. Pay particular attention to the synchronizer rim tooth faces.

The tooth contact of the meshing gears should cover the entire working surface which must be smooth and unworn. Check the gear backlash. Its assembly value is 0.10 mm, the wear limit being 0.20 mm.

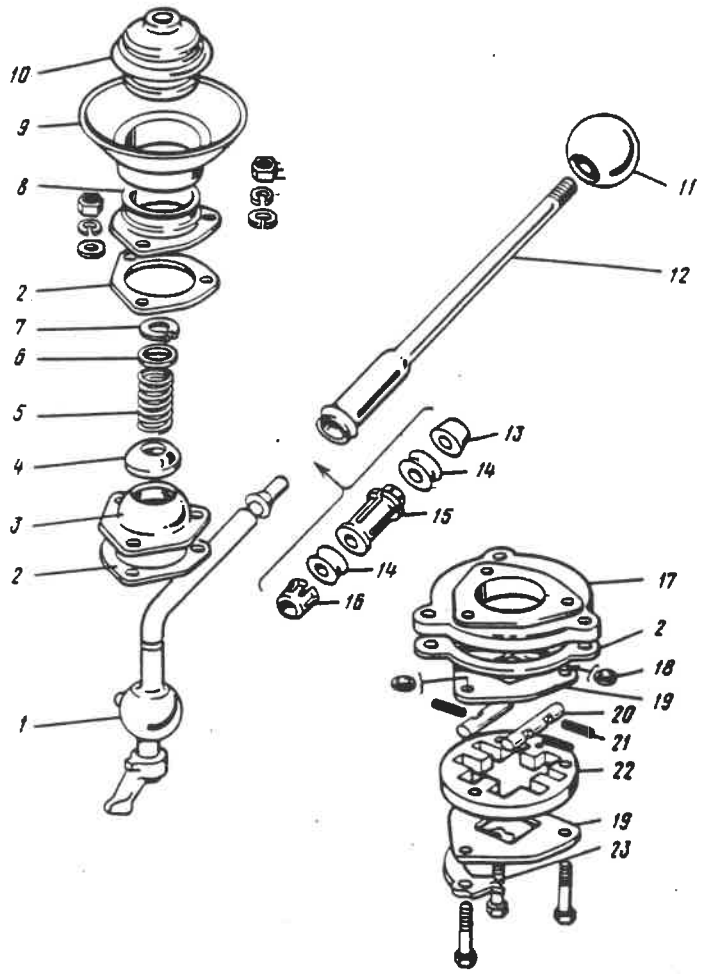


Fig.3-33. Parts of Gearshift Lever and Mechanism:
1 - gearshift lever; 2 - gasket; 3 - ball support; 4 - spherical washer; 5 - spring; 6 - ring; 7 - retaining ring; 8 - flange; 9 - cup; 10 - boot; 11 - knob; 12 - lever rod; 13 - thrust pad; 14 - flexible bushing; 15 - spacer bushing; 16 - locking bushing; 17 - gearshift lever housing; 18 - sealing ring; 19 - guide plate washer; 20 - guide bar; 21 - spring; 22 - guide plate; 23 - reverse interlock plate

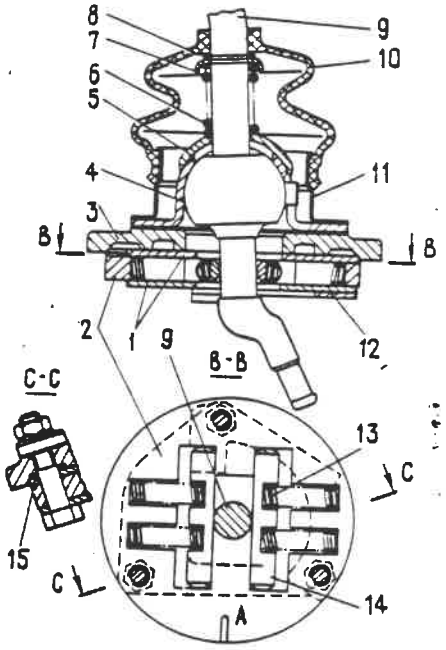


Fig.3-34. Gearshift Mechanism:
1 - guide plate washer; 2 - guide plate; 3 - gearshift lever housing; 4 - ball support; 5 - spherical washer; 6 - spring; 7, 8 - retaining rings; 9 - gearshift lever; 10 - boot; 11 - flange; 12 - reverse lock plate; 13 - spring; 14 - guide strip; 15 - sealing ring; A - notch

The assembly clearance between the 1st and 5th speed gears and their bushings and that between the main shaft and the 2nd and 3rd speed gears should be 0.05 - 0.10 mm; the wear limit for this clearance is 0.15 mm.

The gears worn beyond this limit should be replaced by new ones.

Bearings. The ball and roller bearings must be in perfect condition. Their radial clearance should not exceed 0.05 mm.

Pressing the inner race against the outer one by fingers, rotate one of the races back and forth and see that the rolling motion is smooth and unobstructed. The surfaces of the balls and rollers and those of the bearing races must be free of damage. Replace the defective bearings by new ones. To replace the clutch shaft front bearing use remover A.40006 (Fig.2-11) which permits to perform this operation without removing the flywheel.

Shift bars and forks. The gearshift forks must not be distorted. The shift bars should be free to slide in the housing bores without considerable looseness.

Examine the shift bars interlock retainers, detent balls and springs. Replace these parts if they show signs of jamming and wear.

Synchronizer hubs, sleeves and baulk rings.

Check the hubs for traces of binding, particularly on the sliding surfaces.

Pay particular attention to the condition of the sleeve tooth faces.

See that the surfaces of the baulk rings are not excessively worn. Replace them, if their faces bear against the synchronizer sleeves. Any roughness interfering with free sliding should be removed with a superfine file. The parts worn beyond the permissible limits should be replaced.

TRANSFER CASE

The design of the transfer case is illustrated in Figs 3-35 and 3-36.

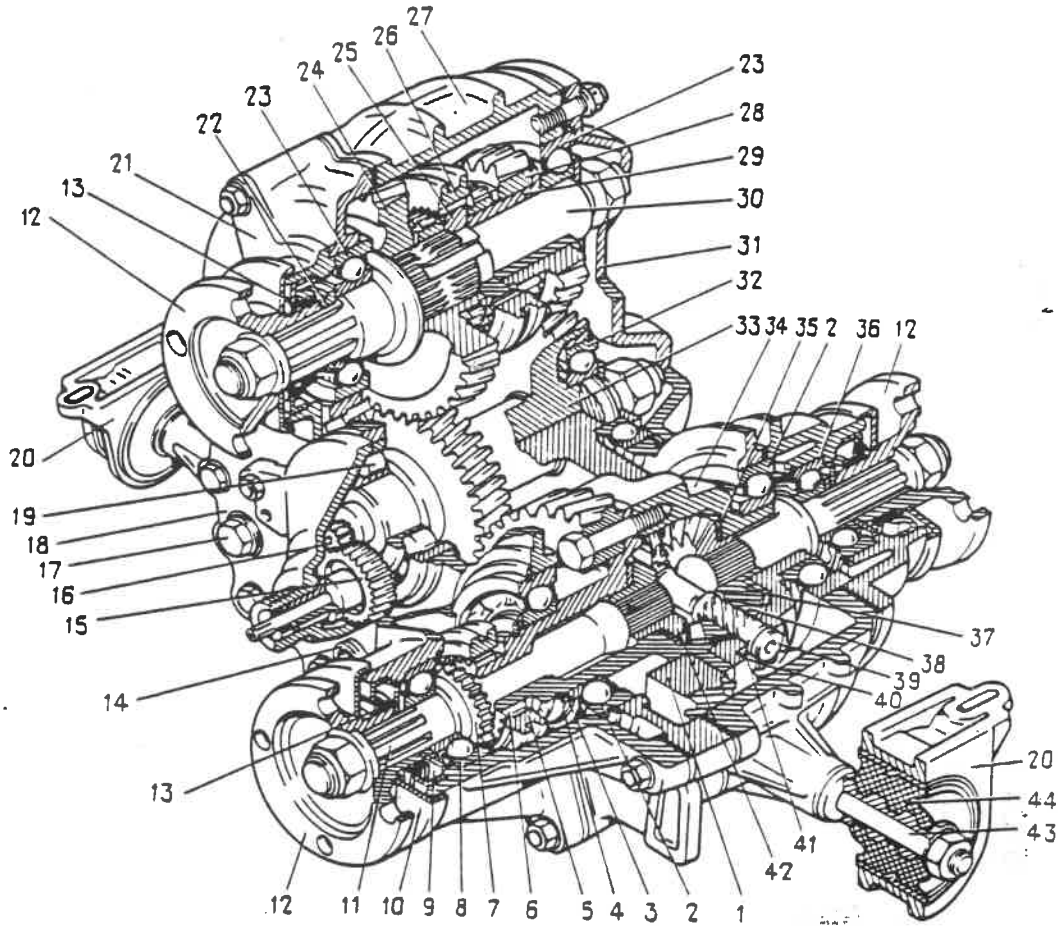


Fig.3-35. Transfer Case:
1 - driven gear; 2 - differential bearings; 3 - spring washer; 4 - lock ring; 5 - differential lock coupling; 6 - differential housing toothed rim; 7 - front axle drive shaft toothed rim; 8 - front axle drive shaft bearing; 9 - oil slinger; 10 - mud guard; 11 - front axle drive shaft; 12 - flange; 13 - gland; 14 - oil drain plug; 15 - speedometer drive driven gear; 16 - speedometer drive driving gear; 17 - oil filler and level check plug; 18 - transfer case front cover; 19 - countershaft roller bearing; 20 - transfer case mount bracket; 21 - drive shaft bearing cover; 22 - bearing thrust ring; 23 - drive shaft bearings; 24 - high speed gear; 25 - shifter sleeve hub; 26 - shifter sleeve; 27 - transfer case housing; 28 - low speed gear; 29 - low speed gear bushing; 30 - drive shaft; 31 - rear cover; 32 - countershaft ball bearing; 33 - countershaft; 34 - differential housing; 35 - rear axle drive gear thrust washer; 36 - rear axle drive shaft bearing; 37 - rear axle drive gear; 38 - differential pinion; 39 - pinion shaft; 40 - pinion shaft lock ring; 41 - spring washer; 42 - front axle drive gear; 43 - transfer case mount pivot; 44 - mount bracket rubber pad

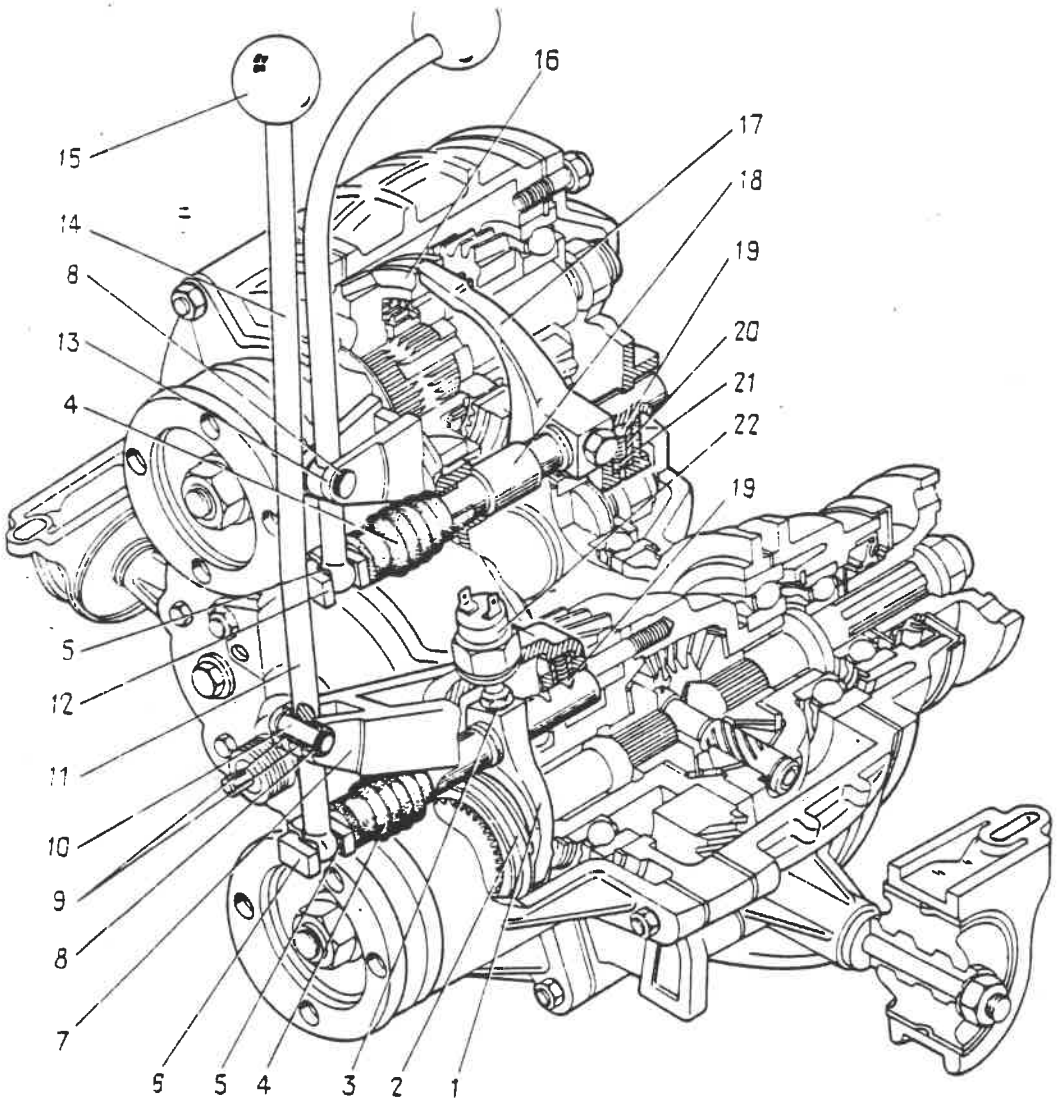


Fig.3-36. Transfer Case Control Mechanism:
1 - differential lock sleeve fork; 2 - differential lock sleeve; 3 - fork stop bolt; 4 - rod boot; 5 - lever spring; 6 - differential lock fork rod; 7 - front axle drive housing cover; 8 - lock washer; 9 - lever axle bushing; 10 - lever axle; 11 - differential lock lever; 12 - gearshift fork bar; 13 - gearshift lever bracket; 14 - gearshift lever; 15 - lever knob; 16 - shifter sleeve; 17 - shifter sleeve fork; 18 - spacer bushing; 19 - detent ball; 20 - detent spring bushing; 21 - detent spring; 22 - differential lock warning lamp switch

Trouble Shooting

Cause	Remedy
Vibration of Transfer Case and Body Floor (in Front Seat Area) at Starting from Rest and Acceleration to 80 km/h	
1. Misalignment of transfer case relative to engine unit	1. Align transfer case
2. Loose or damaged supports of transfer case or rear support of engine unit	2. Tighten attachment nuts and bolts or replace supports

Continued

Cause	Remedy
3. Stiff turning or binding in one of planes of front or rear propeller shaft joints	3. Repair universal joints or replace shafts assembly
4. Incomplete release of parking brake	4. Adjust parking brake
5. Stiff turning of constant velocity universal joint of intermediate propeller shaft	5. Check condition of boot and joint. If joint parts are damaged, replace joint

Continued

Cause	Remedy
Vibration of Transfer Case and Body Floor (in Front Seat Area) in Motion (especially at 80 - 90 km/h)	
1. Propeller shafts out of balance	1. Replace or repair propeller shafts
2. Centre differential out of balance	2. Replace or repair centre differential
3. Binding in universal joints of front or rear propeller shaft	3. Repair universal joints or replace propeller shafts in assembly
4. Binding of constant velocity universal joint of intermediate propeller shaft	4. Check condition of boot and joint. If parts are damaged, replace them
5. Loose bolts and nuts of engine mounts or defective engine mounts	5. Tighten up bolts and nuts or replace engine mounts
6. Bending of bolts and flexible coupling flange of intermediate shaft	6. Replace bolts or intermediate propeller shaft
Noise on Turns or During Slipping of Wheels	
1. Difficult rotation of differential pinions on shaft	1. Replace worn or damaged parts
2. Jamming of axle drive gears in differential housing	2. Replace worn or damaged parts
3. Damaged working surface of pinion shaft	3. Replace worn or damaged parts
4. Excessive end play of axle drive gears in differential housing	4. Set a clearance of 0 - 0.10 mm with adjusting shims
Difficult Gearshifting or Differential Locking	
1. Sleeve jammed on splines of hub or differential housing	1. Dress off any burrs, nicks or scores, replace defective parts
2. Nicks on teeth of smaller rim of high or low speed gears, also on teeth of sleeves and on splines of front axle drive shaft	2. Dress off any nicks and burrs, replace faulty parts
3. Bent fork or shift bar	3. Straighten distorted parts
4. Distortion of transfer case control levers	4. Straighten levers or replace them by new ones, if necessary
5. Jamming of control levers on axles	5. Remove levers, clean axles and bushings. Replace faulty parts
Uncontrollable Disengagement of Gears or Differential Lock	
1. Wear of gear and sleeve teeth	1. Replace worn parts

Continued

Cause	Remedy
2. Detent springs lost their resilience or its parts heavily worn	2. Replace springs or worn parts
3. Incomplete engagement of gears and differential lock caused by distortion of control parts or nicks on gears, sleeves and splines	3. Straighten or replace distorted parts, dress down nicks and burrs; replace defective parts
Leakage of Oil	
1. Sealing gaskets damaged	1. Replace gaskets
2. Loosening of cover-to-housing nuts and studs	2. Tighten up nuts and studs at places of leakage
3. Shaft glands worn or damaged	3. Replace glands
4. Worn sealing rings of transfer case shift bars	4. Replace sealing rings

Methods of Detecting Causes of Vibration of Transfer Case and Body Floor (in Front Seats Area)

First of all note the speed at which vibration of the transfer case appears and then proceed to detecting its cause.

Test No.1

Set the transfer case and gearbox levers in neutral and start the engine. Raise the crankshaft speed to the value corresponding to the car speed at which vibration appears.

If vibration appears on the motionless car, check attachment and condition of the engine mounts as they cause the vibration.

Test No.2

If test No.1 does not reveal vibration, set the transfer case levers in neutral, start the engine, shift into the direct drive in the gearbox and set the crankshaft speed corresponding to the car speed at which vibration of the transfer case appears.

If vibration is detected on the motionless car, its cause is a defect in the intermediate propeller shaft (unbalance, bending of the bolts or flange of the flexible coupling, jamming in the constant-velocity universal joint.

Test No.3

If tests Nos 1 and 2 do not reveal vibration, proceed with test No.3. For this purpose, race the car to the speed at which vibration is detected

and set the transfer case and gearbox levers in neutral. If vibration persists, the cause of trouble is a defect in the front or rear propeller shafts (unbalance, jamming of the universal joints) or unbalance of the centre differential.

Removal, Installation and Alignment of Transfer Case

Removal. Place the car on an inspection pit or a lift. Release the parking brake lever and set the gearbox and transfer case control levers in neutral. Turn out the screws holding the facing of the floor housing lining and remove the facing. Remove the lever knobs and the outer boots. Turn out the attachment screws and remove the lever hatch lid and the lever sealing inner boot.

Disconnect the speedometer flexible drive shaft from the transfer case and the wires from the differential lock warning lamp transmitter. By turning the propeller shafts, disconnect the propeller shaft flanges from the transfer case shafts and the flange of the intermediate propeller shaft, from the flange of the gearbox main shaft.

Unscrew nuts 3 (Fig.3-37) off bolts of transfer case mount brackets 1 and take off the case complete with the brackets and shims 5 located under the brackets and with the intermediate shaft. Mark each shim so as to put them back in the unchanged number.

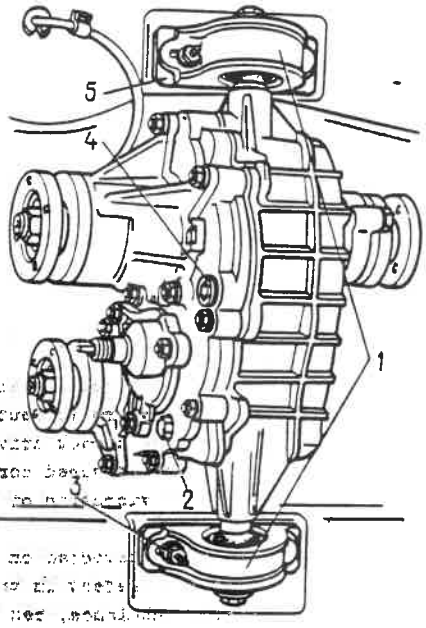


Fig.3-37. Transfer Case Mounting:
1 - transfer case mount brackets; 2 - filler plug; 3 - mount bracket nut; 4 - drain plug; 5 - adjusting shims

To install and align the transfer case, proceed as follows:

- make sure that the engine mount pads are properly installed in the brackets (the centring washers of the front mount pads of the engine should get into the respective holes in the side brackets) and the transfer case mounts tightly fit the body bottom. If necessary, straighten the surface of the body under the mounts;
- mount the transfer case in the car without tightening completely the transfer case mount bracket nuts 4 and 5 (Fig.3-38);
- shifting the transfer case along and across the body and in the vertical plane, find the position in which the flanges of the tranfer case drive shaft and the intermediate propeller shaft are at one level and parallel, with a minimum clearance in between; the shafts of the transfer case should be parallel to the body bottom;
- having installed previously removed adjusting shims under the brackets, tighten completely the transfer case bracket nuts;
- connect the front and rear propeller shafts to the transfer case shafts; connect the flexible shaft to the speedometer drive and fasten the wires to the transmitter of the differential lock warning lamp.

When replacing the transfer case and also in case of sagging of the engine rear mount which causes vibration of the transfer case, select adjusting shims 5 (Fig.3-37) of a required thickness and install them in place.

To select the shims proceed as follows:

- make sure the engine mount pads are installed correctly in the brackets (see 'Engine Removal and Installation');
- separate the flanges of the transfer case drive shaft and the intermediate propeller shaft;
- loosen the nuts holding the transfer case mounts to the body, remove adjusting shims and, shifting the transfer case along and across the body and in the vertical plane, find the position of the transfer case in which the disconnected flanges are at one level and in parallel with each other and the clearance between the flanges is minimum and the transfer case shafts are parallel to the car bottom;
- fill up the clearance between the body floor and the supports with the required number of shims;
- align the centring belts of the flanges, taking care to prevent interference in the transfer case and engine mounts and holding the transfer case in this position, tighten up the previously backed off nuts of the transfer case mounts;
- insert and tighten the bolts of the transfer case and intermediate shaft flanges. If the bolts freely pass into the flange holes, the alignment is correct; otherwise, repeat the flange alignment operation.

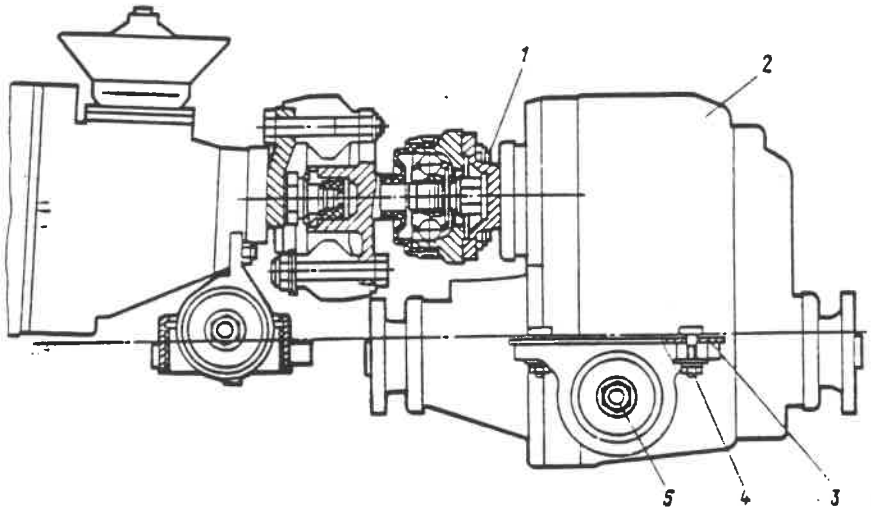


Fig.3-38. Transfer Case Installation Diagram:
1 - flange stud of intermediate propeller shaft and transfer case drive shaft; 2 - transfer case; 3 - adjusting shims; 4 - transfer case-to-body nuts; 5 - transfer case mount bracket-to-pivot fastening nuts

Disassembly and Assembly

Disassembly. Wash the transfer case and drain oil.

Fix the transfer case on a disassembly stand and loosen the flange nuts on the drive shaft and on the front and rear axle drive shafts.

Unscrew the fastening nuts and take off front axle drive housing 1 (Fig.3-39) complete with cover 2, lever, fork, differential lock sleeve and front axle drive shaft. Remove speedometer drive housing 3 complete with the speedometer drive gear.

Take off lock washer 8 (see Fig.3-36), pull out axle 10 and remove differential lock lever 11. Then take off front axle drive housing cover 7, take out the spring and detent ball 19. Unscrew stop bolt 3 of differential lock fork 1 and take out rod 6, fork 1 and lock sleeve 2.

Remove rear cover 31 (see Fig.3-35) complete with the rear axle drive shaft, taking care not to damage the sealing gasket. Then take flanges 12 off the drive shaft and the front and rear axle drive shafts.

Remove the setting rings of the front and rear axle drive shaft bearings. Remove front axle drive shaft 11 from the housing complete with bearing 8, thrust ring and oil slinger 9. Take the rear axle drive shaft out of rear cover 31 complete with bearing 36, thrust ring and oil slinger.

Remove drive shaft front bearing cover 21 and the inspection port lid.

Remove gearshift lever bracket 13 (See Fig.3-36) with the lever. Then take off the lock washer, pull out the axle and remove lever 14.

Unscrew the stop bolt of shifter sleeve fork 17 and, closing the detent socket with a finger, take out carefully shift fork bar 12 and the detent parts.

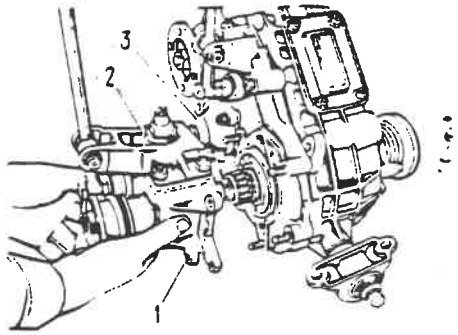


Fig.3-39. Removing Front Axle Drive Housing:
1 - front axle drive housing; 2 - housing cover; 3 - speedometer drive housing

Remove front cover 4 (Fig.3-40) complete with the differential, then the differential bearing setting ring and take the bearing complete with the differential out of the front cover.

Remove the setting rings from the rear bearings of the drive shaft and countershaft and remove both shafts, the drive shaft and countershaft, from the transfer case housing.

Clamp the drive shaft in a vice, remove the thrust ring and rear bearing 11 (Fig.3-41) with a general-purpose remover. Remove low speed gear 9 from the drive shaft complete with bushing 10, then shifter sleeve 8, hub 7 and high speed gear 6.

Disassemble the differential as follows:

- remove lock ring 1 (Fig.3-42) and spring washer 2 of the front bearing;
- remove the front and rear bearings from the differential housing (Fig.3-43) with a general-purpose remover and stop 67.7853.9559;

- turn out the bolts holding the differential driven gear, mark relative position of the differential housing halves by notches and separate the halves;

- remove the differential driven gear;

- remove lock rings 8 (Fig.3-42) and spring washer 14, then press out the pinion shaft and take off the differential pinions and the driving axle gears with supporting washers.

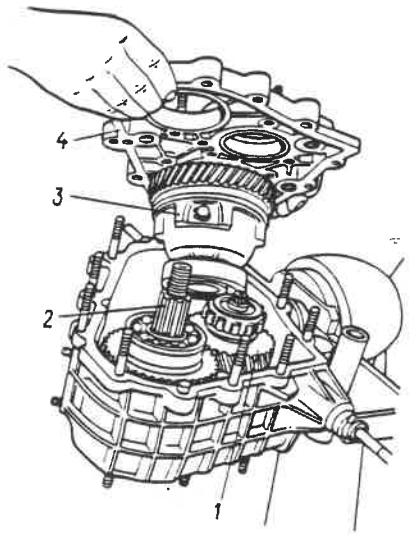


Fig.3-40. Removing Transfer Case Front Cover:
1 - countershaft; 2 - drive shaft; 3 - differential; 4 - front cover

Press the worn or damaged glands out of the front axle drive housing, from the front bearing cover and from the rear cover. Unscrew the nuts from the mount pad axles and take off the bracket assemblies.

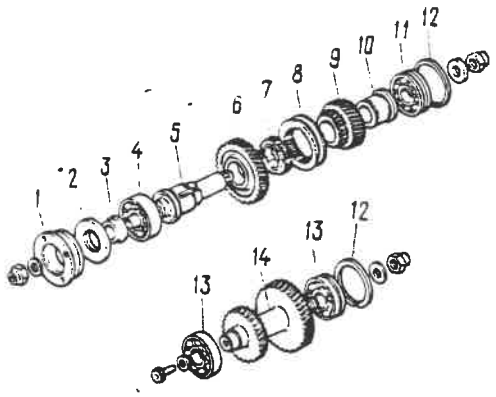


Fig.3-41. Parts of Drive Shaft and Countershaft:
1 - flange; 2 - gland; 3 - bearing thrust ring; 4 - front bearing; 5 - drive shaft; 6 - high speed gear; 7 - hub; 8 - sleeve; 9 - low speed gear; 10 - bushing; 11 - rear bearing; 12 - bearing setting ring; 13 - countershaft bearings; 14 - countershaft

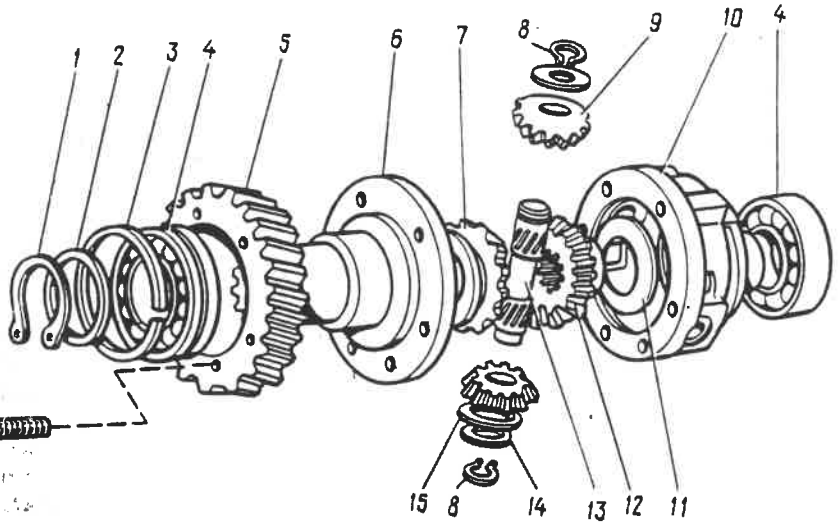


Fig.3-42. Parts of Transfer Case Differential:
1 - lock ring; 2 - spring washer; 3 - bearing setting ring; 4 - differential housing bearings; 5 - driven gear; 6 - differential front housing; 7 - front axle drive gear; 8 - pinion shaft lock ring; 9 - differential pinion; 10 - differential rear housing; 11, 15 - supporting washer; 12 - rear axle drive gear; 13 - differential pinion shaft; 14 - pinion shaft spring washer

Assembly. To assemble the transfer case reverse the disassembly procedure, observing the following requirements:

- assemble the interaxle differential having aligned the match marks on its housings not to disturb the balancing of the unit;
- install the spring washer on the pinion shaft at the side of the blind hole on the shaft end face;
- the axial clearance of each axle drive gear should be 0 - 0.10 mm and the antitorque moment of the gears should not be over 14.7 N.m (1.5 kgf.m). If the clearance is larger, install thicker supporting washers; if the thickest washers fail to provide the prescribed clearance, replace the gears with new ones since they are excessively worn;
- the drive shaft and countershaft should be installed into the transfer case housing simultaneously (see Fig.3-44);
- press the bearings on the differential housing with mandrel 67.7853.9558 (see Fig.3-45);
- coat the working surfaces of glands with grease Литол-24 before installing them into covers and housings;
- tighten the threaded joints with torques indicated in Appendix 1;
- for upsetting the nuts of the transfer case shafts, use fixture 67.7820.9520 (Fig.3-46).

After assembly, pour oil into the transfer case to the lower edge of the filler hole.

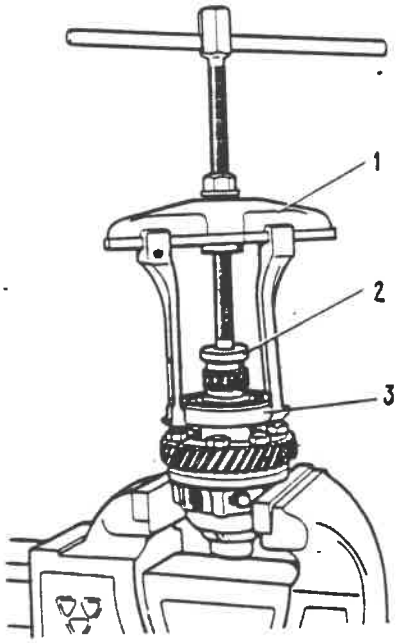


Fig.3-43. Pressing Bearing off Differential Housing:
1 - remover A.40005/1/6; 2 - stop 67.7853.9559; 3 - bearing

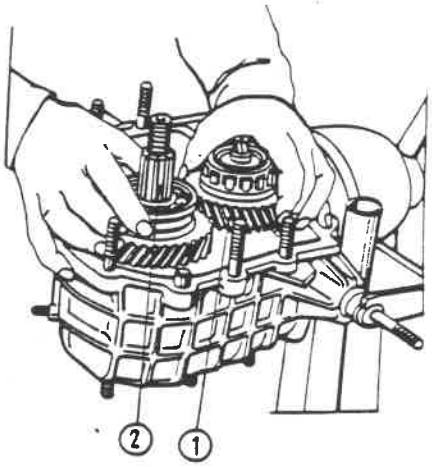


Fig.3-44. Installation of Drive Shaft and Countershaft into Housing:
1 - countershaft; 2 - drive shaft

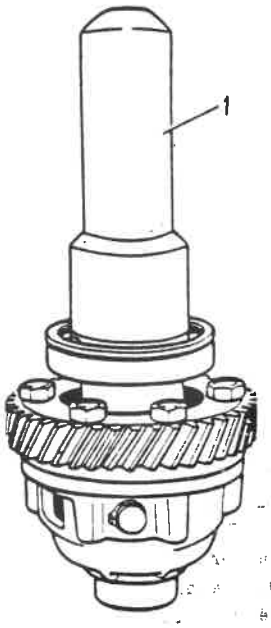


Fig.3-45. Press-Fitting Bearing on Differential Housing:
1 - mandrel 67.7853.9558

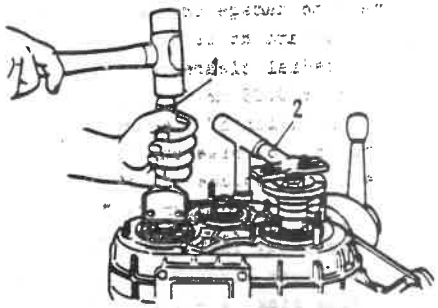


Fig.3-46. Upsetting Rear Axle Drive Shaft Flange Nut:
1 - fixture 67.7820.9520; 2 - flange retainer

Inspection

Before inspection clean thoroughly all the transfer case parts with a brush and scraper, wash them and airblast. Pay particular care to washing and airblasting the bearings; protect them against being quickly rotated and damaged by compressed air jet.

Housing and covers. The housing and covers should be free of cracks; the surfaces of the bearing bores should bear no signs of wear, nicks and chipping. Scoring of the housing surfaces contacting the covers may bring about axial misalignment of the shafts and leakage of oil. Minor scores should be smoothed down with a file. Replace the parts that are heavily damaged or worn.

Glands. Examine the glands closely and replace them even if they are slightly damaged. The working edge should not be worn in width by more than 1 mm.

Shafts. The active surfaces, threaded portions and splines of the shafts should bear no signs of damage. Check runout of the drive shaft and the front and rear axle drive shafts, mounting them on Vee-blocks and turning by hand. Runout of the face part of the thrust bands for the bearings should not exceed 0.01 mm.

When examining the countershaft, take a note of the condition of the gear cluster and the speedometer drive gear. The teeth must not be chipped, nor excessively worn. Replace defective parts.

Gears. When examining the gears, check their teeth and mounting surfaces. The teeth must not be chipped, nor excessively worn. The mounting surfaces of the gears should have no scores nor wear which cause excessively large clearances.

Check the clearance of meshing gears; the assembly clearance should be 0.10 mm, wear limit - 0.20 mm.

The assembly clearance between the low speed gear and bushing and that between the drive shaft and the high speed gear should be 0.05 - 0.10 mm, the wear limit being 0.15 mm. Replace the gears if they are worn in excess of the permissible limits.

Bearings. The ball and roller bearings should have no damage on the raceways, cages, rollers or balls, and no cracks and chipping of the races. The radial clearances of the bearings should not be over 0.05 mm.

Rotation of the dry and clean bearing should produce no noise and it should be even, without jamming. Replace the bearings if they are damaged.

Shift bars, forks. There should be no distortion of the forks and jamming of the shift bars in the housing bores. Replace the detent parts with new ones in case of jamming. The detent springs should also be replaced if they have lost their resilience. The length of the spring under a load of 99.15 - 114.85 N (10.2-11.8 kgf) should be 19 mm, and its free length, 23.3 mm.

Hubs, sleeves. Look for any signs of jamming on the hub of the shifter sleeve, particularly on the sliding surfaces of the sleeves, and on the splines of the differential housing. Dress any scores and burrs with a file. Pay particular attention to the faces of the sleeve teeth; if they are damaged or mutilated, and thus interfere with free movement of the sleeve during gearshifting, replace the sleeve.

Differential. Examine the surfaces of the pinion shafts and of the holes in the differential housing; in case of minor damage, dress the surfaces with fine-grain abrasive cloth; in case of heavy damage, replace the parts by new ones.

Examine the surfaces of the necks of the axle drive gears and of their mounting holes in the differential housing, and condition of the supporting surfaces on the adjusting washers and end faces surfaces of the housings and axle drive gears mating with the washers. Smooth down any discovered roughness with fine-grain abrasive cloth or a superfine file; heavily damaged or worn parts must be replaced.

Remove spring washer 14 (Fig.3-42) and make sure there is no radial displacement of lock rings 8 in the grooves of shaft 13. Replace the lock rings if they are found to be loosely fitted.

Transfer Case Checks

Check an assembled transfer case on a stand for noise, standard of assembly and absence of oil leaks. Carry out the checks successively in high and low gears at the following drive shaft speeds in both directions:

1st mode - 100-200 min^{-1}
2nd mode - 2000-2500 min^{-1}
3rd mode - 3500-4000 min^{-1}

At the 2nd mode, check the transfer case at no load and under load with a variable torque; at the 1st and 3rd mode - under no load.

Check the functioning of the differential at the 1st mode, braking the front and rear axle drive shafts one after the other to a complete stop.

Be sure to shift the gears and lock the differential with the shafts of the transfer case stationary.

There should be no such defects as jamming and rough engagement of gears and differential lock, knocking or uneven noise of gears, and oil leaks.

The design of the propeller shafts is shown in Figs 3-47, 3-48 and 3-49.

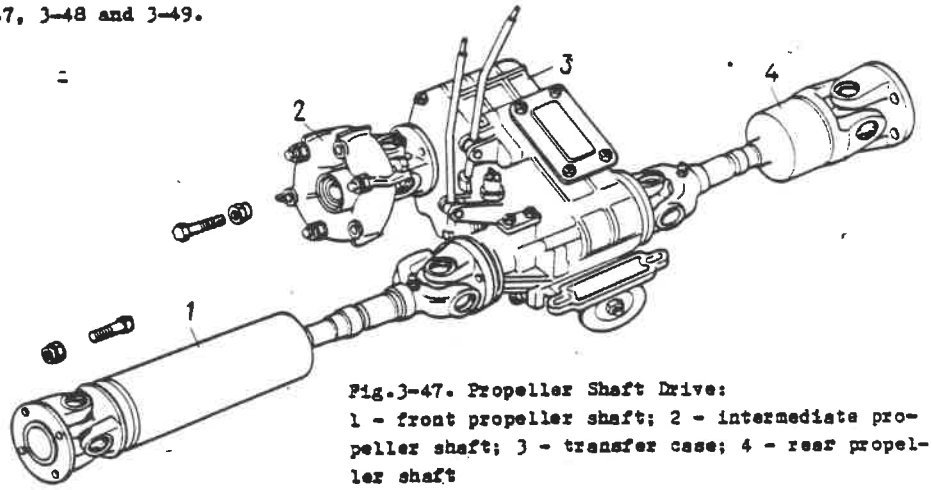


Fig.3-47. Propeller Shaft Drive:
1 - front propeller shaft; 2 - intermediate propeller shaft; 3 - transfer case; 4 - rear propeller shaft

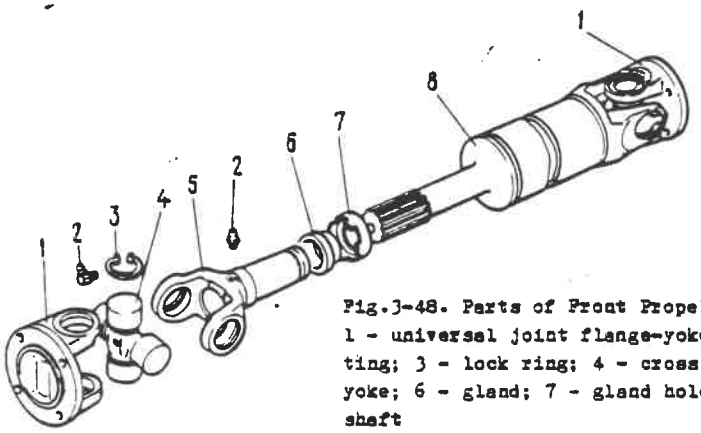


Fig.3-48. Parts of Front Propeller Shaft:
1 - universal joint flange-yoke; 2 - grease fitting; 3 - lock ring; 4 - cross assembly; 5 - slip yoke; 6 - gland; 7 - gland holder; 8 - propeller shaft

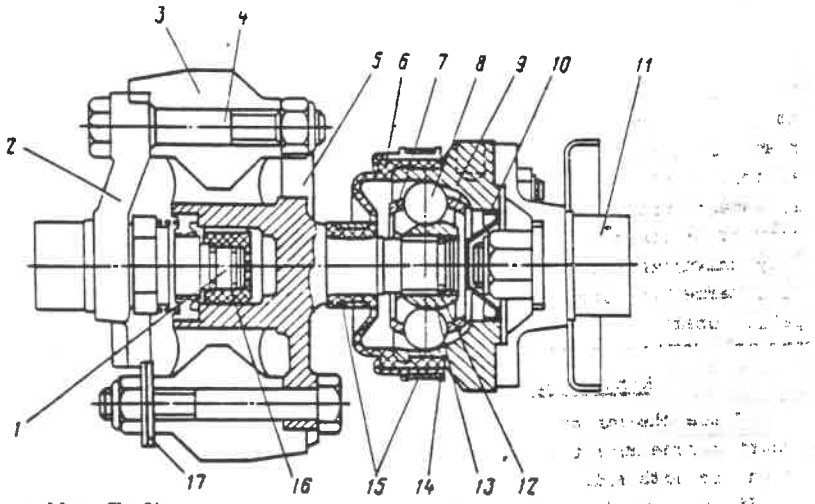


Fig.3-49. Intermediate Propeller Shaft:
1 - gearbox main shaft; 2 - main shaft flange; 3 - flexible coupling insert; 4 - flange attachment bolt; 5 - flexible coupling flange; 6 - boot; 7 - cage; 8 - ball; 9 - constant-velocity universal joint housing; 10 - stopper; 11 - transfer case drive shaft; 12 - retaining ring; 13 - joint casing; 14 - boot protective cover; 15 - clamps; 16 - aligning bushing; 17 - balance plate

Trouble Shooting

Cause	Remedy
Knocking in Propeller Shaft Drive when Starting from Rest, During Quick Acceleration or Gearshifting	
1. Loosening of bolts and nuts of flexible coupling and universal joint flanges	1. Tighten nuts with torques specified in Appendix 1
2. Excessive peripheral clearance in splined joints of front or rear propeller shafts	2. Measure clearance on pitch diameter of splines; replace worn parts if it exceeds 0.30 mm
3. Wear of universal joints	3. Repair joints by replacing worn parts
Noise and Vibration of Propeller Shaft Drive	
1. Distortion of front or rear propeller shafts	1. True up in a press, or replace shafts
2. Unbalance of propeller shafts	2. Check and balance shafts (see "Balancing of Shafts")
3. Wear or damage of flexible coupling flange aligning bushing of intermediate propeller shaft	3. Replace flexible coupling flange bushing
4. Wear of universal joints	4. Repair universal joints by replacing worn parts
5. Loosening of gland holder of front or rear propeller shaft splined joint	5. Compress gland and its holder; replace gland in case of lubricant leaks
6. Insufficient lubrication of splined joints	6. Lubricate splined joints with ZIOL-1 or ZIOL-2V lubricant through grease fittings
Oil Leakage	
1. Loosening of gland holder of front or rear propeller shaft splined joint	1. Compress gland and its holder; replace gland, if worn
2. Damaged protective boot of constant velocity universal joint of intermediate propeller shaft	2. Disassemble joint, change grease and replace boot. If joint parts are damaged, replace joint assembly

Removal and Installation

Place the car on a lift or an inspection pit ensuring free rotation of front and rear wheels at one or both sides.

Fix the car in position reliably, release the parking brake and set the gearbox gearshift lever to neutral.

Remove the front and rear propeller shafts.

Put clamp A.70025 on flexible coupling 3 of the intermediate shaft (Fig.3-14) and, rotating the shaft, unscrew the nuts of the bolts which fasten the flexible coupling to the gearbox main shaft flange. Remove the transfer case (see "Transfer Case") complete with the intermediate shaft. Turn off the nuts of the studs holding the intermediate propeller shaft joint to the flange of the transfer case drive shaft and remove the intermediate propeller shaft.

To install the propeller shafts reverse the removal operations. Prior to installing the intermediate propeller shaft complete with the transfer case, fit the aligning rings of the flexible coupling on the gearbox main shaft. When installing the intermediate propeller shaft provide proper alignment of the gearbox and transfer case shafts (See "Transfer Case", "Installation").

Prior to installing the intermediate propeller shaft apply 2 - 3 g of grease ШРУС-4 to the inner surface of the flange aligning bushing.

Inspection without Disassembly

Clean and wash the propeller shafts and check the universal joints for ease and smoothness of rotation of the yokes and for absence of considerable axial and radial clearances.

Check the propeller shafts for balancing in a balance stand as stated below.

If the yokes rotate smoothly, without jamming, the unbalance of the axle drive shafts does not exceed 1.716 N.mm (175 gf.mm) and that of the intermediate shaft is not over 2.16 N.mm (200 gf.mm) and if there are no leaks of lubricant through the glands of the cross bearings and the boot of the intermediate propeller shaft, it is better to refrain from disassembly of the propeller shafts.

Disassembly

Rear and Front Shafts. Mark the parts with paint or by centre-punching so as to reassemble them in the original position and to keep the balancing of the shafts unchanged.

Clamp the front (rear) propeller shaft in a vice with aluminium jaws. Remove the lock rings by means of round-nosed pliers.

Press the bearing housings out of the universal joint yokes, proceeding as follows:

- rest the propeller shaft by one of the universal joint forks on press support 1 (Fig.3-50). Shift the other yoke 3 of the joint to thrust against the cross by means of special bushing 2 and the rod of the press;
- turn the universal joint yoke through 180° and repeat the above operations, i.e. shift the other end of the yoke to thrust against the cross. When these operations are carried out, the opposite bearing of the cross will partially come out

of the hole in the yoke, and bushing 1 (Fig.3-51) with a cut on its side can be installed into the clearance between the yoke and the cross to press out the bearing completely;

- install bushing 1 (Fig.3-51) onto the cross trunnion and move the universal joint yoke down to press out the bearing;

- proceeding as described above, press out other bearings of the cross.

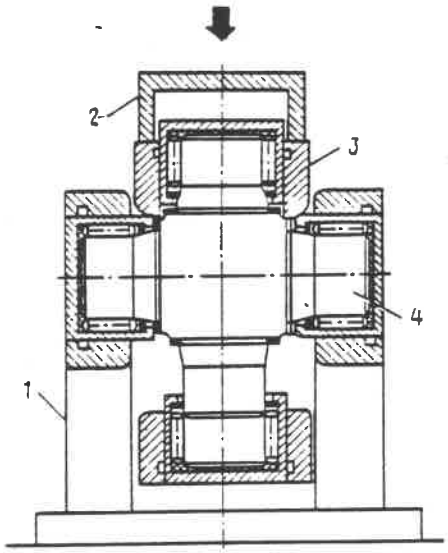


Fig.3-50. Disassembling Universal Joint:
1 - press support; 2 - bushing; 3 - universal joint yoke; 4 - cross

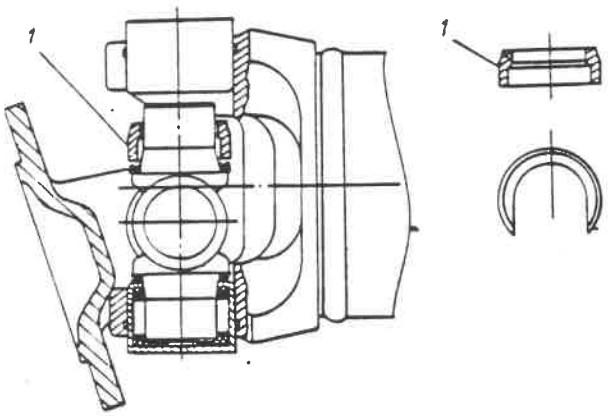


Fig.3-51. Mounting Bushing for Disassembling Universal Joint:
1 - bushing

Intermediate shaft. Disconnect the flexible coupling from flange 5 (Fig.3-49) making a note of the number and location of balancing washers 17 and of the coupling relative to the flange so as to return them where they belong during reassembly.

If boot 6 or cover 14 is damaged and necessity arises to check condition of the joint parts and grease, mark the position of the joint relative to the flexible coupling flange, and disassemble the joint proceeding as indicated under "Front Wheel Drive".

Inspection

Eccentricity check. Mount the front (rear) propeller shaft in centres and rotate it to check the runout of the tube which should not exceed the following limits:

- 0.5 mm at 50 mm from the end welds;
- 0.3 mm in the middle.

If the runout exceeds the above limits, true up the shaft in a press or replace it by a new one.

Splined joint. Check the clearance in the splined joint of the front (rear) shaft slip yoke. The maximum permissible peripheral clearance on the pitch diameter of the splines is 0.30 mm.

Check whether the plug in yoke 5 (see Fig.3-48) is not missing, and examine holder 7 and slip yoke gland 6. Replace the gland, if necessary, and the holder, if it is damaged.

Universal joints. Examine the bearing housings, needles, cross trunnions, glands and end washers.

If the bearing housings, needles and trunnions of the cross, and glands or end washers are damaged or worn out, replace the cross in assembly with the bearings.

The diameter of the hole in the yoke for the needle bearing should not exceed 28.021 mm.

If the working surfaces of the parts of the intermediate propeller shaft joint are damaged or worn down in excess of 0.1 mm, replace the joint assembly.

Flexible coupling. Examine the rubber elements of the flexible coupling. In case of cracks or separation of rubber from the metal inserts, replace the flexible coupling.

Flexible coupling flange. Examine the aligning bushing of the flexible coupling flange. Replace the bushing in case of considerable wear or damage.

Assembly

Assemble the propeller shafts by reversing the disassembly procedure, bearing in mind the following:

- apply 3 - 4 g of ФИОЛ-1 or ФИОЛ-2У grease uniformly to the splined joints;
- while joining the parts, align the marks made on the separable parts before disassembly;
- having assembled the splined joint, apply an axial load to the gland for compressing it by 0.3 - 0.5 mm and compress the holder on the yoke recess.

To assemble the universal joint, proceed as follows:

- remove old thick grease and coat the inner surface of the bearing housing with grease No.158 or ФИОЛ-2У (0.8 - 1.2 g per bearing). Do not coat with grease the cross trunnions to prevent formation of air socket during the assembly. Insert the cross into the holes in the yokes. Press-fit the bearing into one hole in the yoke and fit 1.56 mm thick lock ring 1 (Fig.3-52) into the groove in the yoke. Press-fit the bearing into the other hole in the yoke till the opposite bearing thrusts against the end of the lock ring. The effort of press-fitting should not exceed 15,000 N (1,500 kgf).

Using two gauges 2 with 4 and 3 blades of different thickness, respectively, determine which blade gets tightly in clearance H between bearing bottom and the end face of the yoke groove, and fit into the groove a lock ring of thickness equal to that of the gauge blade.

Note. One gauge has blades, 1.45, 1.48, 1.52 and 1.56 mm thick, and the other, 1.60, 1.64 and 1.67 mm thick.

If the gauge blade of the minimum thickness (1.45 mm) fails to get into clearance H, replace ring 1 with another one, 1.4 mm thick, and repeat the operations described above.

If the blade of the maximum thickness (1.67 mm) is loose in clearance H, fit the ring 1.67 mm thick, having removed ring 1 and again carry out the operations described above.

Note. Measure the clearance with the gauge blades from the pipe side.

The lock rings of eight sizes (in thickness) are delivered for spares, distinguished by the colour: 1.45 - not painted; 1.48 - yellow; 1.52 - brown; 1.56 - blue; 1.60 - black; thickness of 1.64, 1.67 and 1.40 blades are to be determined by measurements.

Having installed the lock rings, strike the yokes with a plastic-head hammer. As a result, the clearance between the bearing bottom and the lock ring will be taken up, and clearances within 0.01-0.04 mm will be formed between the bearing housings and the cross trunnion ends. After assembly, check the universal joint yokes for easy turning, and the shafts for balancing.

When assembling the intermediate propeller shaft joint proceed as stated under "Front Wheel Drive". When assembling the joint install cage 7 (Fig.3-49) with its face towards the transfer case drive shaft and pack 20 cm^3 of grease Longterm-00, Dow Corning Company, into the joint.

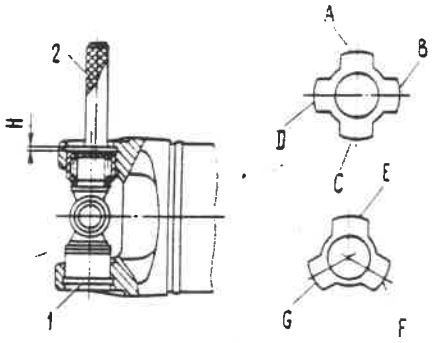


Fig.3-52. Assembling Universal Joint:
1 - lock ring; 2 - gauge; H - clearance
A, B, C, D, E, F, G - gauge blades 1.45, 1.48, 1.52, 1.56, 1.60, 1.64 and 1.67 mm thick

Balancing of Shafts

The front and rear propeller shafts are dynamically balanced on special stands by welding up metal balancing plates.

At a rotation speed of 5500 min^{-1} the unbalance of the shafts checked on surfaces A and B (Fig.3-53) should not exceed 1.72 N.mm (175 gf.mm); during the balancing check it should not exceed 2.16 N.mm (220 gf.mm).

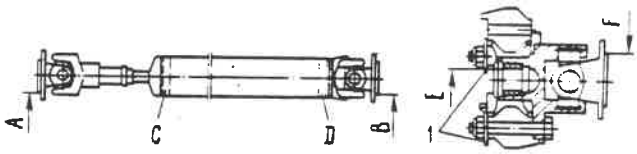


Fig.3-53. Balancing Propeller Shafts:
1 - balancing washers; A, B, E, F - balance check surfaces; C, D - shaft bearing surfaces on balancing machine

The balance of the intermediate propeller shaft is checked at 800 min^{-1} on surfaces E and F. The required balance is ensured by the use of balancing washers 1 (Fig.3-53) and by drilling of joint housing. The unbalance should not exceed 1.96 N.mm (200 gf.mm).

Caution:

If the shaft parts have been replaced during repairs, the shafts have to be balanced.

After balancing the shafts, coat the bearings of the universal joints with grease No.158 or ФИОЛ-2У through the grease fittings. Grease-gun until grease shows up through the seals.

The design of the rear axle is illustrated in Fig.3-54.

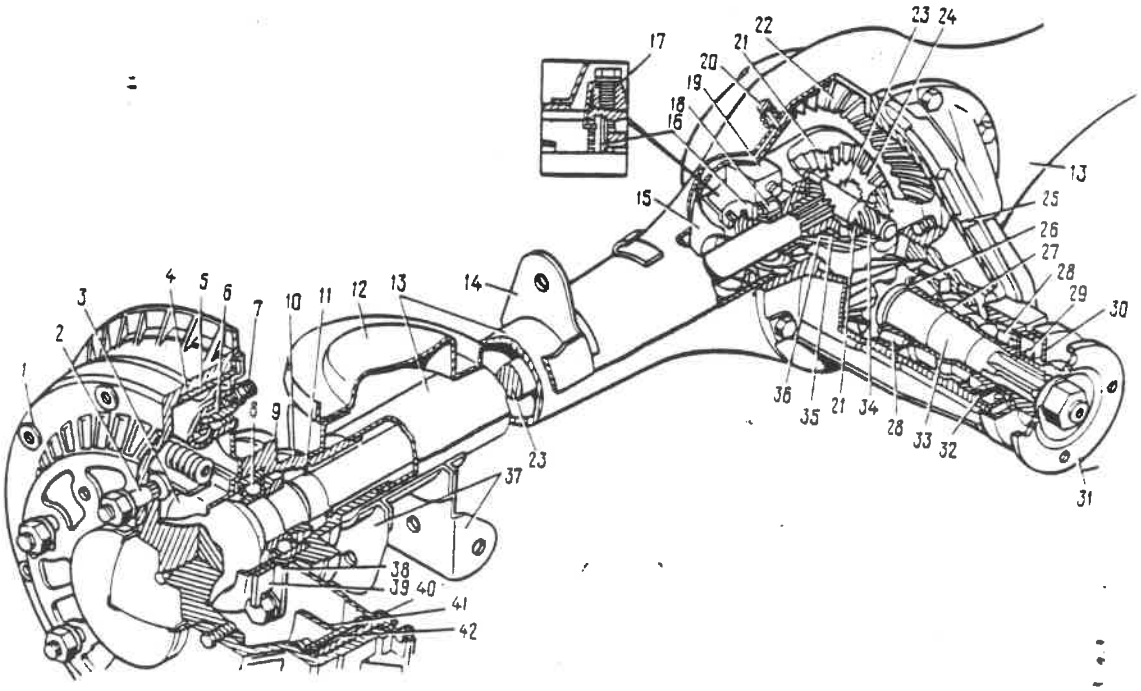


Fig.3-54. Rear Axle:
1 - wheel cap; 2 - brake drum and wheel bolt; 3 - axle-shaft bearing oil slinger; 4 - brake drum; 5 - drum cast iron ring; 6 - rear wheel brake cylinder; 7 - brake bleeder union; 8 - axle-shaft bearing 9 - bearing lock ring; 10 - rear axle beam flange; 11 - gland; 12 - suspension spring seat; 13 - rear axle beam; 14 - rear suspension upper longitudinal radius rod bracket; 15 - axle-shaft guide; 16 - differential bearing adjusting nut; 17 - nut lock plate; 18 - differential case bearing; 19 - bearing cover; 20 - breather; 21 - differential pinion; 22 - final drive ring gear; 23 - axle shaft; 24 - axle-shaft gear; 25 - rear axle final drive housing; 26 - adjusting ring; 27 - bearing spacer bushing; 28 - drive pinion bearings; 29 - drive pinion gland; 30 - mud guard; 31 - flange; 32 - oil slinger; 33 - final drive pinion; 34 - differential pinion shaft; 35 - axle-shaft gear supporting washer; 36 - differential case; 37 - suspension bracket; 38 - axle-shaft bearing fastening plate; 39 - plate bolt holder; 40 - rear brake backing plate; 41 - rear brake shoe; 42 - shoe lining

Trouble Shooting

Cause	Remedy
Rear Wheels Noisy	
1. Wheel loose on axle shaft	1. Tighten wheel nuts
2. Axle shaft ball bearing worn or damaged	2. Examine axle shaft and replace bearing
Constant Loud Noise of Rear Axle	
1. Distortion of rear axle beam; axle-shaft bearings damaged	1. Straighten out beam and check its dimensions; replace axle-shaft bearings

Continued

Cause	Remedy
2. Axle-shafts distorted or their runout is excessive	2. Straighten out axle-shafts. If they are badly damaged, replace axle-shafts with new ones
3. Incorrect adjustment, damage or wear of gears or bearings of final drive	3. Reveal trouble, repair final drive
4. Wear or maladjustment of differential bearings	4. Remove final drive, repair it and adjust

Continued

Cause	Remedy
Noise During Acceleration and Engine Braking	
1. Wrong meshing of final drive gears after repairs	1. Adjust gear mesh
2. Axle shaft bearings damaged	2. Replace bearings
3. Lack of oil	3. Restore oil level and look for leaks through seals or in rear axle beam
4. Improper meshing of final drive gears	4. Adjust gear mesh
5. Excessive clearance in drive pinion bearings caused by looseness of flange fastening nut or by wear of bearings	5. Check antitorque moment of drive pinion, tighten nut or replace defective parts
Noise on Turns	
1. Axle shaft bearings damaged	1. Replace bearings
Knocking on Starting from Rest	
1. Wear of pinion case bore for differential pinion shaft	1. Replace pinion case
2. Loose bolts of rear suspension radius rods	2. Tighten up bolts
Oil Leaks	
1. Drive pinion gland worn or damaged	1. Replace gland
2. Wear of axle shaft gland symptomized by oiling of brake backing plates, drums and shoes	2. Check runout of axle shaft, deflection of beam; true up or replace damaged parts
3. Loose bolts of final drive housing; defective sealing gaskets	3. Tighten bolts; replace sealing gaskets

Removal and Installation

The operations related to the removal and installation of the rear axle are dealt with in the "Rear Suspension" Chapter. To remove the rear axle, it is sufficient to disconnect the suspension radius rods and shock absorbers only from the rear axle beam.

When installing the rear axle, tighten the nuts of the radius rod bolts in keeping with the recommendations of the "Rear Suspension" Chapter.

After installation, bleed the brake system and adjust the service and parking brake systems as instructed under "Brakes".

Fill the rear axle housing with ТАД-17И oil through the oil filler hole.

Disassembly and Assembly

Disassembly. Remove the brake pipeline with the Tee-piece from the rear axle, disconnecting the end of the pipes from the wheel brake cylinders.

Put the rear axle on a repair stand and drain oil from the housing.

Remove the brake drum, unscrew the brake backing plate nuts and, using impact remover 67.7823.9516 (Fig.3-55), take out the axle shaft complete with the oil slinger, bearing fastening plate, bearing and lock ring. Remove the brake backing plate and the sealing ring. If the gland wants replacement, pull it out of the axle beam flange.

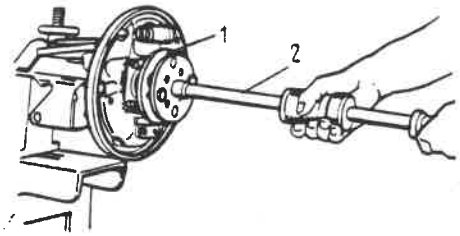


Fig.3-55. Pressing out Axle Shaft:
1 - axle shaft; 2 - impact remover 67.7823.9516

Perform the same operations at the other end of the beam and remove the final drive.

To assemble the rear axle, reverse the disassembly operations, observing the following recommendations:

- coat the threads of the final drive bolts with a sealing compound, having first degreased the bolts and their threaded holes in the rear axle beam;
- before installing the gland of the axle shaft bearing, coat it with Литол-24 grease and install the gland into the beam flange using driver A.70157;
- coat the mounting band on the axle shaft and the surface of its flange contacting the brake drum with graphite grease or ЛСЦ-15 grease.

Install the brake drums only after mounting the rear axle in the car and fastening the cable ends to the parking brake levers.

Checking Rear Axle Beam

Examine thoroughly the axle beam, particularly after a collision. A distorted beam may cause noise in the rear axle and rapid wear of the tyres.

Check the axle beam for distortion both in the horizontal and vertical planes. Proceed as follows.

Secure flange A.70172 to each end of the beam, put the beam, with both its flanges resting on identical Vee-blocks located on a surface plate at least 1600 mm long, so that the surface for mounting the housing on the beam is in the vertical plane.

Check the axle beam for deformation, setting an angle gauge against the outer surface (Fig.3-56) and side surface (Fig.3-57) of flange A.70172; if the beam is not distorted, the angle gauge will fit snugly against the surfaces.

Check the value of distortion with a feeler gauge. If a 0.2 mm-feeler gauge goes on either flange, straighten the beam.

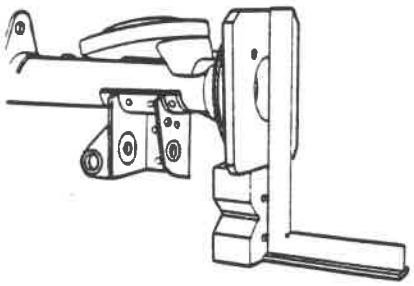


Fig.3-56. Checking Rear Axle Beam for Vertical Deformation with Angle Gauge Applied to Outer Face of Flange A.70172

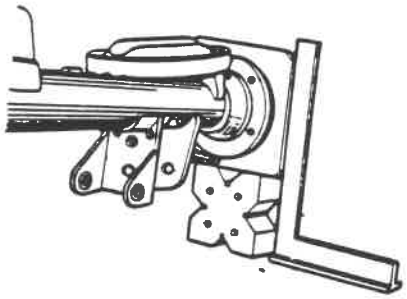


Fig.3-57. Checking Rear Axle Beam for Twisting Deformations with Angle Gauge Applied to Side Surface of Flange A.70172

Using an angle gauge (Fig.3-58), check the final drive mounting surface for perpendicularity to the bearing surface of flange A.70172. The 0.2 mm feeler gauge must not go.

Turn the axle beam through 90° and place it on Vee-blocks. Apply the angle gauge to the outer surface of the flange (Fig.3-59). The angle gauge should fit tightly. Otherwise, check the value of distortion with a feeler gauge. The 0.2 mm feeler gauge must not go.

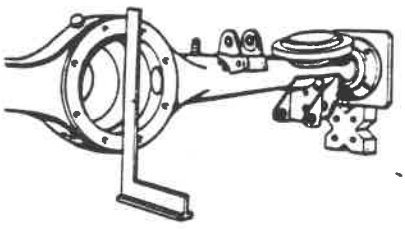


Fig.3-58. Checking Final Drive Mounting Surface for Perpendicularity

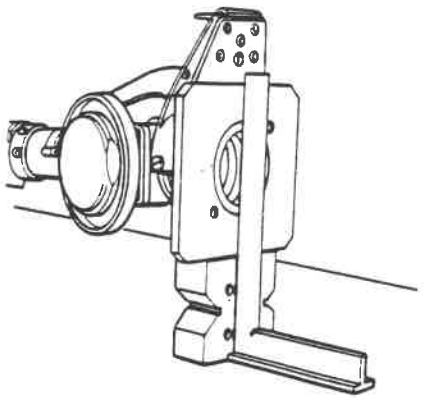


Fig.3-59. Checking Rear Axle Beam for Horizontal Deformation with angle Gauge Applied to Outer Face of Flange A.70172

If deformation exceeds the value stated above, straighten the beam as advised below.

Having trued up the beam, wash it carefully, clean and install the magnetic plug, then check the following:

- quality of the welds and tightness of the beam;
- cleanliness inside the beam (absence of burrs, chips and oil remnants) and of the beam breather.

Paint the beam on the outside to protect from corrosion.

Straightening Rear Axle Beam

Fasten flanges A.70172 (the ones used for straightening, not for checking) to each end of the beam and put the latter on the supports of a hydraulic press so that the ends of hold-down crossbeam 2 (Fig.3-60) are in the zone of distortion. Most likely the zone of distortion will be located 200-300 mm from the faces of the beam flanges.

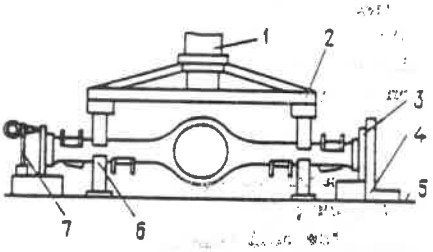


Fig.3-60. Straightening Rear Axle Beam Diagram: 1 - hydraulic cylinder; 2 - hold-down crossbeam; 3 - flange A.70172; 4 - angle gauge; 5 - press table; 6 - support; 7 - indicator bracket

Set bracket 7 with the indicator so that the indicator rod bears against the upper part of the flange side surface, and the indicator pointer is at the division showing the value of beam distortion measured with the feeler gauge during the beam checks.

Install either a bracket with an indicator or angle gauge 4 on the other side of the beam.

Install supports 6 under the beam (in the zone of distortion), straighten up the beam by the hydraulic press first in the horizontal, then in the vertical plane, checking the results of straightening with the indicator or with a feeler gauge and angle gauge 4.

The maximum force on the press during beam straightening should not exceed 98 kN (10,000 kgf) to avoid excessive deformation of the housing section.

Note. If the height of support 6 has been correctly selected by experiment, the beam may be straightened without angle gauge or indicator checks.

Remove the beam from the press and check it as advised above, replacing "straightening" flanges A.70172 by the "checking" ones.

If the prescribed equipment is not available, the rear axle beam may be straightened, as an exception, in turn, at each end with subsequent check of the beam distortion on both sides (see "Checking of Rear Axle Beam").

Axle Shafts

Removal and Installation

Remove the wheel and the brake drum.

Unscrew the nuts which hold the brake backing plate to the axle beam; using remover 67.7823.9516 and supporting the backing plate, pull out the axle shaft complete with the oil slinger, bearing fastening plate and lock ring.

If gland replacement is necessary, remove it from the axle beam flange.

Install the axle shaft by reversing the removal operations, and taking care not to damage the working edge of the gland. Before installing the brake drum, lubricate the mounting band on the axle shaft with graphite or ЛСЦ-15 grease. After installation, check the functioning of the axle shafts on the road.

Inspection

Examine the parts of the axle shaft and make sure that:

- the ball bearing is neither worn nor damaged; replace the bearing if its axial clearance is larger than 0.7 mm;
- the bearing and its lock ring are not displaced from their initial positions; if the inner race of the bearing turns on the axle shaft, replace the lock ring;
- the bearing fastening plate and the oil slinger are free of damage;
- the axle shaft is not distorted, and the mounting surfaces are not damaged; the runout of the axle shaft measured in centres on the journal for the gland should not exceed 0.08 mm. Before putting the axle shaft in the centres clean the alignment holes on the axle shaft carefully of dirt and rust.

If any parts mounted on the axle shaft are found to be worn or damaged, replace them by new ones observing the rules laid down below and using special devices. Minor bending of the axle shaft should be corrected by trueing up. After trueing, the runout of the flange face measured in the centres should not exceed 0.05 mm. If it is greater but does not exceed 0.08 mm, the flange face may be turned in a lathe to eliminate face runout. Turning must not reduce the thickness of the flange by more than 0.2 mm.

Removal of Lock Ring

The lock ring of the axle shaft bearing must be removed and installed only in a hydraulic press.

First, bend outward holders 39 (Fig.3-54) of the bolts which fasten plate 38 with the oil slinger and brake backing plate and take out the bolts.

Put the half-rings of remover 67.7823.9529 around the bearing and set the axle shaft vertically so that the half-rings rest on the lock ring.

Put the axle shaft in the press (Fig.3-61) and apply a gradually increasing force to the splined end of the axle shaft until the lock ring comes off. The lock ring must not be reused, it must be replaced by a new one.

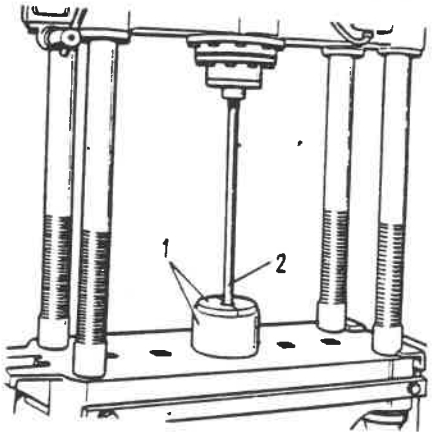


Fig.3-61. Pressing out Axle-Shaft Bearing Lock Ring:
1 - fixture; 2 - axle shaft

Check the axle shaft mounting surface for notches and other defects; replace the axle shaft by a new one, if necessary.

Assembly

Set the axle shaft vertically with its flange resting on ring 7 (Fig.3-62) of installation tool 67.7823.9530.

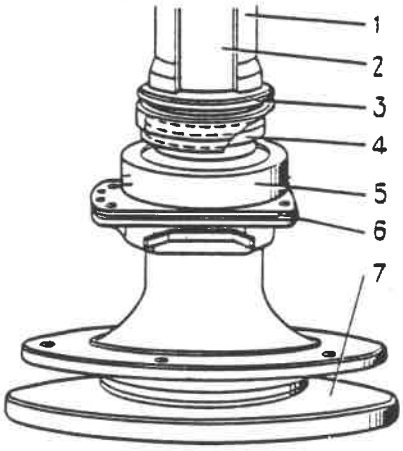


Fig.3-62. Press-Fitting Axle-Shaft Bearing Lock Ring:
1 - driver; 2 - axle shaft; 3 - holder; 4 - lock ring; 5 - bearing; 6 - bearing fastening plate and oil slinger assembly; 7 - supporting ring

Connect the oil slinger of the axle shaft bearing and the bearing fastening plate with the gasket by two screws and install these parts on the axle shaft; install the axle shaft ball bearing.

Insert a new lock ring into special holder 3 and heat it in an oven approximately to 300 °C so that the temperature of the ring during pressing on the axle shaft be 220 - 240 °C.

Drive the lock ring on the axle shaft with driver 1 in a press, applying a force not higher than 58.8 kN (6,000 kgf) until the inner race of the bearing is clamped between the lock ring and the axle shaft shoulder.

Having pressed-on the lock ring, check to see that it will not be displaced under an axial load of 19.6 kN (2,000 kgf). For this purpose, place the assembled axle shaft in a tester (Fig.3-63) and clamp the lock ring in a special vice.

Place the rod of indicator 1, division value - 0.01 mm, against the axle shaft flange. Set the indicator pointer to zero and apply the axial load specified above by tightening the screw of the tester to 78.5 - 83.3 N.m (8 - 8.5 kgf.m) with a torque-indicating wrench. The screw will bear through a ball against the end of the axle shaft. The applied force should not cause any clearance, however small, between the lock ring and the inner race of the bearing.

Remove the load by turning off the tester screw and make sure that the indicator pointer returns to zero. This means that there has been no shifting of the lock ring over the axle shaft. Failure of the indicator pointer to come back to zero indicates that the lock ring has been displaced, and the axle shaft assembly must be replaced by a new one.

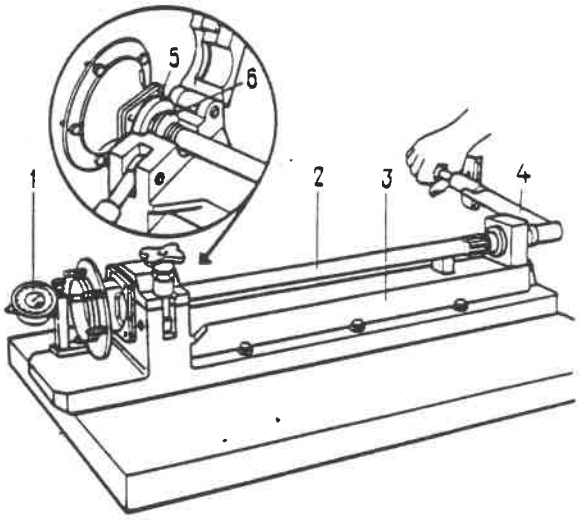


Fig.3-63. Checking Effort to Press Out Axle-Shaft Bearing Lock Ring:
1 - indicator; 2 - axle shaft; 3 - tester; 4 - torque-indicating wrench; 5 - bearing; 6 - bearing lock ring

Having checked the fit of the lock ring, install the bolts which fasten the plate and oil slinger 6 (Fig.3-62) and fix them by bending the bolt holders inward.

Measuring Axle Shaft End Play on Car

Loosen the nuts of the rear wheels. Put chocks under the front wheels and jack up the rear axle. Release the parking brake and set the gearshift lever to neutral.

Remove the wheels and brake drums. Screw gauge 02.7834.9504 (Fig.3-64) to the axle shaft, pass the rod extension of indicator 1 through one of the two holes in the axle shaft until the rod extension comes to bear against the brake backing plate or oil slinger and secure the indicator.

Measure the end play with the indicator, applying a force of about 49 N (5 kgf) in both directions along the rear axle axis. The permissible end play shall not exceed 0.7 mm.

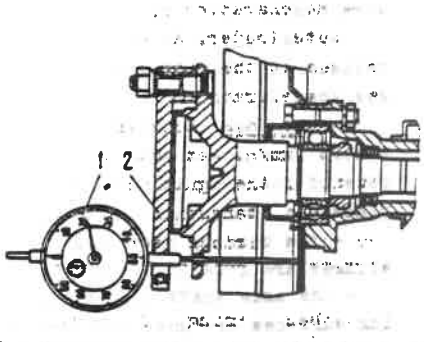


Fig.3-64. Measuring Axle-Shaft End Play with Wheel and Brake Drum Removed:
1 - indicator; 2 - gauge

Final Drive

The rear axle final drive assembly is shown on Fig.3-65.

It is unified with the VAZ-2106 final drive and bears mark 6 on its housing.

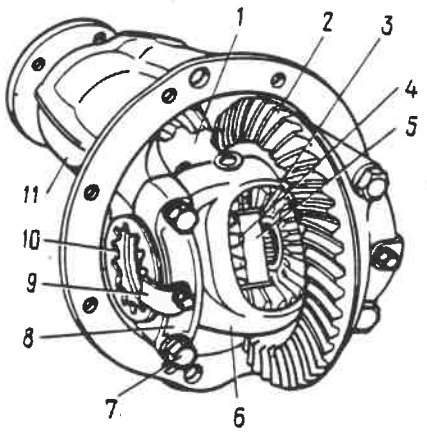


Fig.3-65. Rear Axle Final Drive Assembly:
1 - drive pinion; 2 - ring gear; 3 - differential pinion; 4 - axle-shaft gear; 5 - differential pinion shaft; 6 - differential case; 7 - differential case bearing cover bolts; 8 - differential case bearing cover; 9 - locking plate; 10 - bearing adjusting nut; 11 - final drive housing

Identifying Final Drive Defects by Noise

Look for final drive troubles in the following sequence:

Test No.1. In order to identify the exact nature of the noise, drive the car on a highway at approximately 20 km/h.

Then accelerate the car gradually to 90 km/h, listening to various kinds of noise and taking a note of the speeds at which they appear and vanish.

Let go of the accelerator pedal and slow down the car by the engine without applying the brakes.

In the course of deceleration, note the changes in the character of the noise and the moments when it gets louder. As a rule, the noise arises and vanishes at the same speeds both during acceleration and deceleration.

Test No.2. Accelerate the car approximately to 100 km/h, set the gearshift lever in neutral, turn off the ignition switch and allow the car to coast to standstill; listen to the character of the noise at various deceleration speeds.

Caution:

When turning off the ignition switch, take care not to move it farther than necessary so as to avoid operation of the antitheft device.

The noise occurring during this test and corresponding to that noticed during Test No.1 is not caused by the final drive gears since they produce no noise when not under load.

On the contrary, the noise registered during Test No.1 and not recurring during Test No.2 may be caused by the final drive gears or by the bearings of the drive pinion or differential.

Test No.3. Start the engine on a stationary and braked car and, throttling it up gradually, compare the arising noises with those registered during the previous tests. If the noises resemble those noticed during Test No.1, they are caused not by the final drive but by some other units.

Test No.4. The noises noticed during Test No.1 and not observed during the subsequent tests are caused by the final drive; to confirm, jack up the rear wheels, start the engine and throw in the 4th speed gear. This will prove that the noise is actually produced by the final drive and not by other units, e.g. suspension or body.

Removal of Final Drive

If the final drive alone has to be removed, do the following:

- drain oil from the rear axle housing;
- jack up the rear end of the car, put it on supports and remove the wheels and brake drums;
- unscrew the nuts which hold the brake backing plate to the axle beam and pull out the axle shafts from the differential case;
- disconnect the propeller shaft from the final drive, put a support under the final drive housing, remove the bolts that fasten this housing to the rear axle beam and take the final drive out of the beam taking care not to damage the gasket.

Installation of Final Drive

Prior to installing the final drive, clean the axle beam thoroughly of oil. Put a sealing gasket on the mating surface, insert the final drive into the beam and fasten it with bolts. Before installation, coat the bolt threads with a sealing compound. Before applying the sealing compound, degrease carefully the bolts and the holes in the beam. Attach the propeller shaft to the final drive, install the axle shafts and brake drums.

Install the wheels with tyres and tighten the wheel nuts preliminarily. Having installed both wheels, remove the supports and lower the car, then tighten the wheel nuts with a torque-indicating wrench.

Fill the rear axle beam with oil, first having cleaned and screwed in the drain plug.

Disassembly of Final Drive

Mount the final drive on a stand. Remove locking plates 9 (see Fig.3-65), unscrew bolts 7 and remove covers 8 of the differential case bearings,

adjusting nuts 10 and roller bearing outer cups. Mark covers 8 and outer cups of the bearings before removal so as to install them back where they belong during subsequent reassembly.

Take the differential case from final drive housing 11 complete with ring gear 2 and bearing inner cones.

To remove drive pinion 1 and associated parts, proceed as follows:

- turn the final drive housing over so that its throat points up (Fig.3-66) and unscrew the flange nut with wrench 2, holding drive pinion flange 3 with retainer 1;
- remove the flange and take out the drive pinion complete with the adjusting ring, rear bearing inner cone and spacer sleeve;
- take the gland, oil slinger and front bearing inner cone from the final drive housing;
- press out the outer cups of the front and rear bearings with driver A.70198;
- remove the spacer sleeve from the drive pinion and, using removers A.40005/1/7 and A.45008 (Fig.3-67), remove the inner cone of the rear roller bearing;
- take off the drive pinion adjusting ring.

To disassemble the differential:

- remove roller bearing inner cones 2 (Fig.3-68) from differential case 3 using general-purpose remover A.40005/1/6 and stop A.45028;
- unscrew the ring gear bolts and drive the differential pinion shaft out of the case;
- turn the axle shaft gears and the differential pinions so that the latter roll out through the differential ports, wherefrom they can be taken out;
- remove the axle shaft gears with supporting washers.

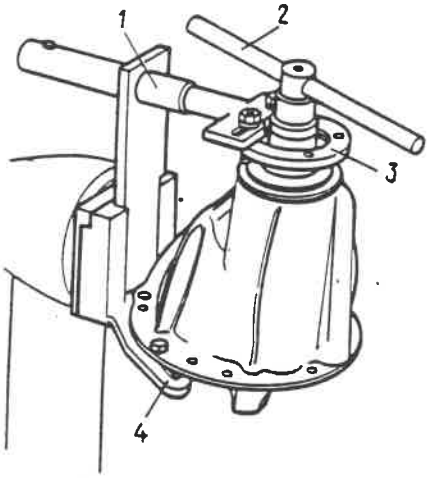


Fig.3-66. Turning off Drive Pinion Nut:
1 - drive pinion flange retainer; 2 - socket wrench; 3 - drive pinion flange; 4 - bracket

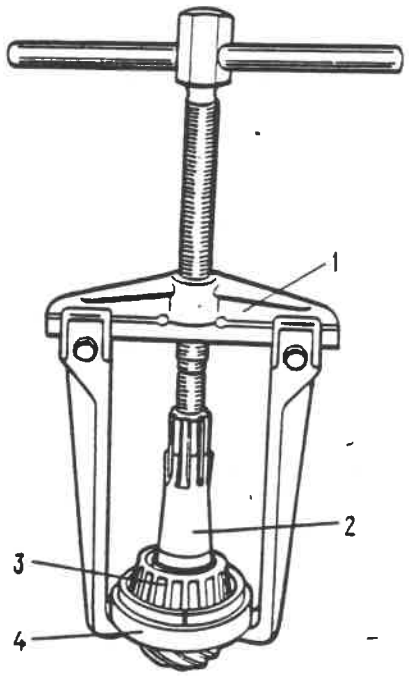


Fig.3-67. Removing Drive Pinion Rear Bearing Inner Cone with General-Purpose Remover A.40005/1/7:
1 - general-purpose remover; 2 - drive pinion; 3 - bearing cone; 4 - mandrel A.45008

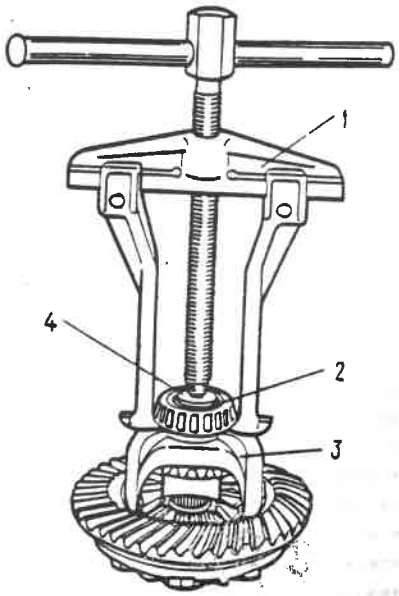


Fig.3-68. Removing Inner Cone of Differential Case Bearing with General-Purpose Remover A.40005/1/6:
1 - general-purpose remover tool; 2 - bearing inner cone; 3 - case; 4 - stop A.45028

Inspection of Parts

Wash the final drive parts thoroughly before inspection to facilitate detection of any faults and wear.

Look for the traces of damage on the gear teeth and check for correct tooth contact pattern on the working surfaces of teeth; replace any heavily worn parts; identify the cause of improper tooth contact.

Note. Replacement drive pinions and ring gears are available in sets matched for noiseless operation and proper tooth contact. Therefore, if one of these parts is damaged, both should be replaced as a set.

Examine the differential pinion shafts and the bores in the pinions; minor defects can be eliminated by polishing with fine abrasive cloth. In case of heavy damage, replace the parts by new ones.

Inspect the axle shaft gear journals and their seats in the differential case, condition of holes in the case for the pinion shaft. Attend to the discovered defects in the same manner as in the previous operation, replace the worn or damaged parts, if necessary.

Inspect the surfaces of the axle shaft gear supporting washers and eliminate even the slightest defects. If replacement is necessary, select washers of the proper thickness.

Inspect the roller bearings of the drive pinion and differential case; they should be unworn and have smooth working surfaces. Replace the bearings if there is any doubt as to their serviceability; faulty bearings may cause noise and seizure of gears.

Look for distortion and cracks in the final drive housing and differential case and replace them, if necessary.

Assembly of Final Drive

Strict observance of the assembly and adjustment rules given below will ensure reliable functioning of the final drive.

The parts of the final drive are illustrated in Fig.3-69.

Assembly of Differential

Coat the axle shaft gears with transmission oil and install them complete with the supporting washers and differential pinions through the ports in the differential case. Turn the pinions and the axle shaft gears so as to align the rotation axis of the differential pinions with the axis of the port in the case, then insert the pinion shaft.

Check the axial clearance of each axle shaft gear; it should be 0 - 0.10 mm; the antitorque moment of the differential gears should not exceed 14.7 N.m (1.5 kgf.m).

In case of an unduly large clearance caused by wear of the differential parts, replace the supporting washers of the axle shaft gears by thicker ones. If the above-stated clearance cannot be provided even after installation of the thickest washer, it means that the gears are heavily worn and must be replaced by new ones.

Secure the ring gear on the differential case.

Using installation driver A.70152, press-fit the inner cones of the roller bearings on the differential case.

Installation and Adjustment of Drive Pinion

A correct position of the drive pinion relative to the ring gear depends on the thickness of the adjusting ring installed between the thrust face of the drive pinion and the inner cone of the rear bearing.

Select the adjusting ring, using dummy pinion A.70184 and thickness gauge A.95690 with an indicator. Proceed as follows:

Secure the final drive housing on a stand and press the outer cups of the drive pinion front and rear bearings into the housing. Use driver A.70185 for the front bearing, and A.70171 for the rear one (Fig.3-70).

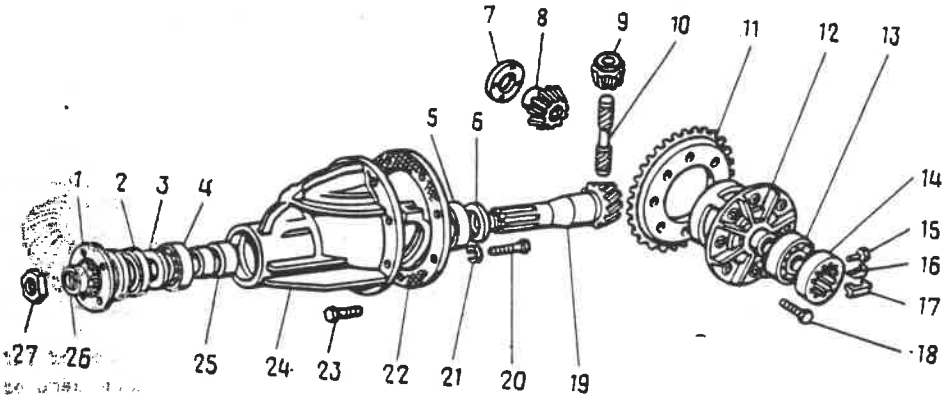


Fig.3-69. Rear Axle Final Drive Parts:
1 - drive pinion flange; 2 - gland; 3 - oil slinger; 4 - front bearing; 5 - rear bearing; 6 - drive pinion adjusting ring; 7 - axle-shaft gear supporting washer; 8 - axle-shaft gear; 9 - differential pinion; 10 - differential pinion shaft; 11 - ring gear; 12 - differential case; 13 - differential case bearing; 14 - adjusting nut; 15 - locking plate bolt; 16 - locking plate; 17 - locking plate; 18 - ring gear bolt; 19 - drive pinion; 20 - cover bolt; 21 - spring washer; 22 - gasket; 23 - final drive fastening bolt; 24 - final drive housing; 25 - spacer bushing; 26 - plain washer; 27 - drive pinion flange nut

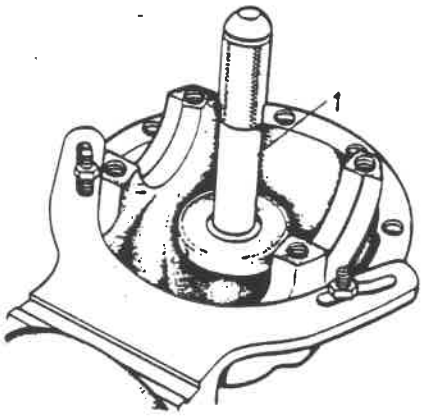


Fig.3-70. Installing Drive Pinion Rear Bearing Outer Cup Using Driver:
1 - driver A.70171

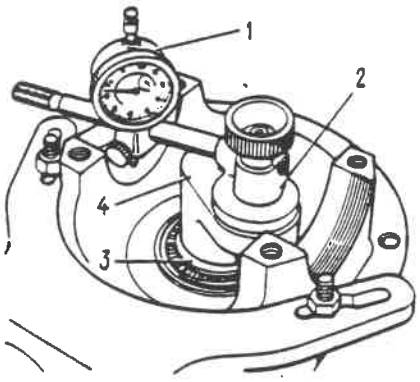


Fig.3-71. Determining Thickness of Drive Pinion Adjusting Ring:
1 - indicator; 2 - gauge A.95690; 3 - drive pinion rear bearing; 4 - dummy pinion A.70184

Using driver A.70152, install the inner cone of the rear bearing on dummy pinion A.70184 and insert the latter into the throat of the final drive housing (Fig.3-71).

Install the inner cone of the front bearing and the drive pinion flange and draw up the nut with a torque of 7.85 - 9.8 N.m (0.8 - 1 kgf.m), rotating the dummy pinion to make the bearing rollers find their correct position.

Secure thickness gauge A.95690 on the face of dummy pinion 4 and set the gauge indicator, division values 0.01 mm to zero, placing its rod on the same face of dummy pinion A.70184. Then shift indicator 1 so that its rod rests on the seating surface of the differential case bearing.

Turning dummy pinion 4 with the indicator to the right and left, stop it when the indicator pointer is at minimum value "a_1" (Fig.3-72) and write down the reading. Repeat this operation on the seating surface of the other bearing and find value "a_2".

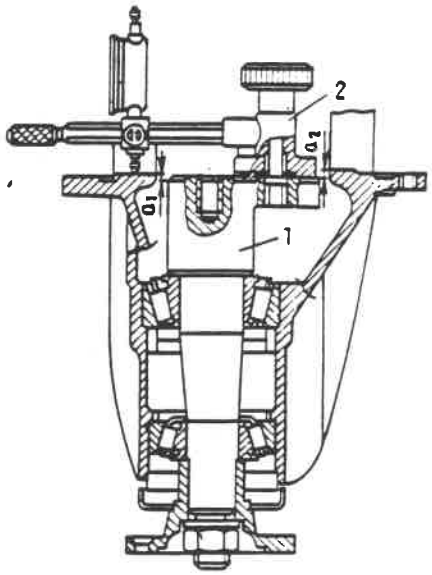


Fig.3-72. Taking Measurements to Determine Thickness of Drive Pinion Adjusting Ring:
1 - dummy pinion A.70184; 2 - gauge A.95690 with indicator; a_1 and a_2 - distance from dummy pinion face to journals of differential bearings

Determine thickness "S" of the drive pinion adjusting ring; this thickness is the algebraic difference of "a" and "b".

$$S = a - b,$$

where:

a - arithmetical mean of distances between faces of dummy pinion 1 (Fig.3-64) and journals of differential bearings:

$$a = \frac{a_1 + a_2}{2},$$

b - deviation of drive pinion from nominal position in millimeters. Value of deviation is marked on drive pinion (Fig.3-73) in hundredth fractions of millimeter with plus of minus sign.

In determining the thickness of the adjusting ring, the sign and the unit of measurement of "b" should be taken into account.

Example. Let value "a" found by means of the indicator be 2.91 mm ("a" is always positive), and the deviation of the drive pinion given after its Serial No. be "-14". To find value "b" in millimeters, the value of deviation should be multiplied by 0.01 mm:

$b = -14 \times 0.01$ mm $= -0.14$ mm.

Now find thickness of the pinion adjusting ring in millimeters:

$S = a - b = 2.91$ mm $- (-0.14$ mm$) = 2.91$ mm $+ 0.14$ mm $= 3.05$ mm.

In this case install the adjusting ring 3.05 mm thick.

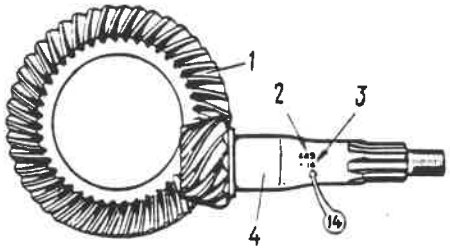


Fig.3-73. Final Drive Pinion and Gear:
1 - ring gear; 2 - Item No.; 3 - correction to nominal position in hundredths of millimeter; 4 - drive pinion

Put the adjusting ring of the required thickness on the drive pinion and, using driver A.70152 (Fig.3-74), install the rear bearing inner cone removed from dummy pinion A.70184. Put in position the spacer bushing.

Caution:

During repairs of the rear axle final drive, be sure to use a new spacer bushing if the housing, final drive gears or pinion bearings have been replaced. If, however, these parts have not been replaced, the old spacer bushing may be used.

Insert the drive pinion into the final drive housing and put in place the inner cone of the front bearing, the oil slinger, gland, drive pinion flange and washer.

Screw the nut on the drive pinion shank, lock the pinion flange and tighten the nut with a torque specified below.

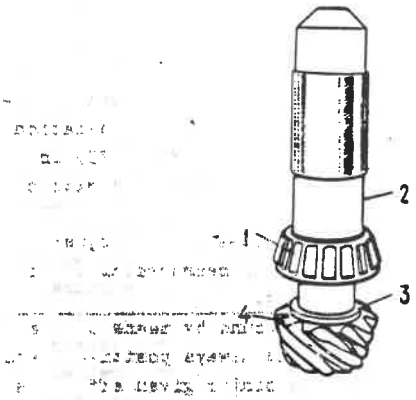


Fig.3-74. Installing Rear Bearing Inner Cone on Drive Pinion:
1 - roller bearing cone; 2 - driver A.70152; 3 - adjusting ring; 4 - drive pinion

Preloading of Drive Pinion Bearings

It is essential that the drive pinion bearings be properly preloaded in order to limit the axial displacement of the pinion under working loads. This preloading is checked by dynamometer 02.7812.9501 (Fig.3-75) which measures the antitorque moment of the drive pinion.

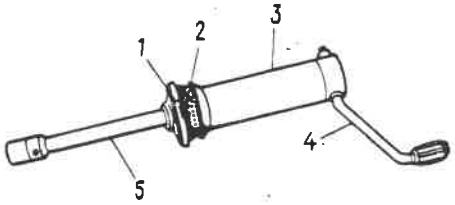


Fig.3-75. Dynamometer 02.7812.9501:
1 - movable index; 2 - torque-limiting index; 3 - body; 4 - handle; 5 - bar with end-piece inserted into adapter bushing

The antitorque moment determines the degree of bearing tightening. This moment should be 157 - 196 N.cm (16-20 kgf.cm) for new bearings and 39.2 - 58.8 N.cm (4 - 6 kgf.cm) for the bearings after a run of 30 km and more.

Tighten the flange nut with a torque of 118 - 255 N.m (12 - 26 kgf.m), periodically checking with a dynamometer the resistance of the bearings to rotation of the drive pinion.

To check the antitorque moment place the dynamometer on adapter sleeve 3 (Fig.3-76), set torque limiting index 2 (Fig.3-75) to the 196 N.cm (20 kgf.cm) scale division and turn handle 4 a few revolutions clockwise. When turning the pinion, see that movable index 1 does not go beyond index 2 and indicates not less than 157 N.cm (16 kgf.cm).

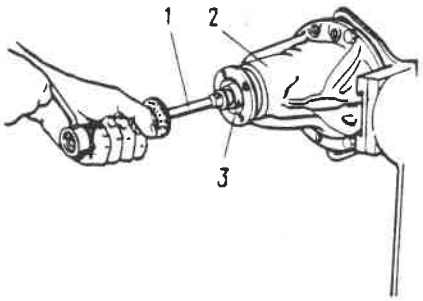


Fig.3-76. Checking Preload of Drive Pinion Bearing:
1 - dynamometer 02.7812.9501; 2 - housing; 3 - adapter sleeve

If the antitorque moment is under 157 N.cm (16 kgf.cm), or 39.2 N.cm (4 kgf.cm) for the bearings after 30 km of run, tighten the pinion flange nut without exceeding the prescribed preload and recheck the antitorque moment of the drive pinion.

If the antitorque moment exceeds 196 N.cm (20 kgf.cm), or 58.8 N.cm (6 kgf.cm) for bedded-in be-

arings, which means that preload of the bearings is excessive, replace the spacer sleeve by a new one since it has been overloaded and distorted to a size which denies the possibility of correct adjustment. Having replaced the spacer sleeve, repeat the assembly operations performing appropriate adjustment and checks.

Installation of Differential Case

Assemble the differential case complete with the bearing outer cups and install it into the housing.

Install two adjusting nuts 4 (Fig.3-77) so that they contact the bearing cups.

Install the bearing covers and tighten the fastening bolts with a torque-indicating wrench.

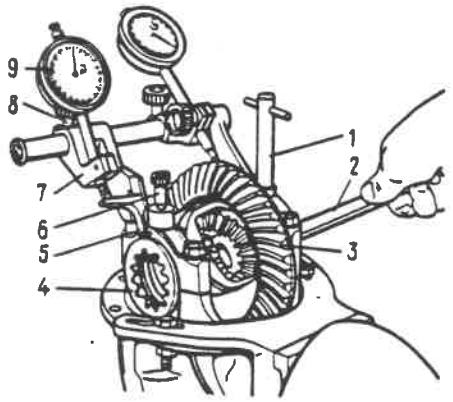


Fig.3-77. Checking Preload of Differential Case Bearings with Gauge A.95688/R:
1 - gauge screw; 2 - wrench A.55085; 3 - ring gear; 4 - adjusting nut; 5 - intermediate lever; 6 - fastening screw; 7 - indicator bracket; 8 - bracket screw; 9 - bearing preload indicator

Adjusting Preload of Differential Case Bearings and Backlash of Final Drive Gears

These operations should be carried out concurrently, using gauge A.95688/R and wrench A.55085.

Secure the gauge on the final drive housing (Fig.3-77) by turning screws 1 and 6 into the holes for the bolts which fasten the adjusting nut locking plates.

Move bracket 7 along the guide of the gauge until lever 5 comes in contact with the external side surface of the cover and tighten screw 8.

Loosen screws 1 and 3 (Fig.3-78) and set bracket 4 so that the rod of indicator 2 rests on the tooth flank of the ring gear at the tooth edge; then tighten screws 1 and 3.

Adjust the pinion-to-gear backlash preliminarily to 0.08 - 0.13 mm by turning the adjusting nuts. Check the backlash with indicator 2, at the same time rocking ring gear 6. This should be done without preloading the bearings. The adjusting nuts must only touch upon the bearings; otherwise, the preload reading will be wrong.

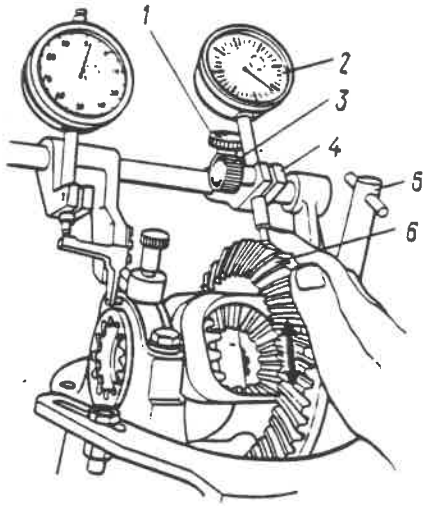


Fig.3-78. Checking Backlash of Final Drive Gears with Gauge A.95688/R:
1 - bracket screw; 2 - backlash indicator; 3 - indicator bar clamping screw; 4 - indicator bracket; 5 - fastening screw; 6 - ring gear

Tighten the bearing adjusting nuts successively and uniformly. This will make the differential bearing covers move apart, thus increasing distance D (Fig.3-79) by 0.14 - 0.18 mm.

Having set a correct preload of the differential case bearings, check finally backlash of the final drive gears. It must remain unchanged.

If the backlash is greater than 0.08 - 0.13 mm, shift the ring gear towards the pinion; shift it away, if the backlash is smaller. In order to retain the preset preload of the bearings, move the ring gear by tightening one of the bearing adjusting nuts and loosening the other nut through the same angle.

For accurate performance of this operation, watch the readings of indicator 9 (Fig.3-77) which reads the previously set preload of the bearings. Tightening one of the nuts will change the indicator reading, because distance "D" between the covers (Fig.3-79) will increase and so will the preload of the bearings. Therefore, keep loosening the other nut until the indicator pointer returns to the initial position.

Having moved the ring gear, check the backlash by indicator 2 (Fig.3-78). Repeat the adjustment if the backlash is other than required.

Remove gauge A.95688/R, install the locking plates of the adjusting nuts and fasten them by bolts with spring washers. The spare locking plates are available in two types, with one or with two lugs to suit the position of the nut slot.

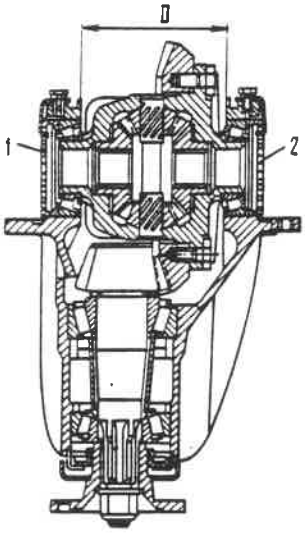


Fig.3-79. Checking Preload of Differential Case Bearings:
D - distance between differential bearing covers;
1, 2 - adjusting nuts

The final drive units can be adjusted and repaired on a special stand which is also suitable for checking the gears for noise and for the position and pattern of the tooth contact on the working surfaces of the teeth as indicated below.

Checking Tooth Contact of Final Drive Gears

The final check of the final drive gears for proper meshing is carried out on a stand as follows:

- set the adjusted final drive on the stand and coat the working surfaces of the ring gear teeth with a thin layer of lead oxide;
- start the stand; brake the rotating axle shafts by the stand levers so as to obtain the traces of contact with the pinion teeth on the ring gear teeth;
- reverse the rotation of the stand and, braking the gears, obtain the contact traces on the other side of the ring gear teeth which corresponds to the backward movement of the car.

The tooth contact is considered correct if the contact pattern is located uniformly on both sides of the ring gear teeth, nearer to the narrow end of the tooth, occupying two thirds of its length and without extending to the tip and the root of the tooth as shown in Fig.3-80 "e".

The patterns of wrong tooth contact on the active surface of the tooth are illustrated in Fig.3-80 "a", "b", "c" and "d".

Adjustment of the pinion position involving the replacement of the ring calls for the disassembly of the unit.

During assembly, repeat all the operations related to adjusting the preload of the pinion roller bearings, checking the antitorque moment, setting the preload of the differential case roller bearings and adjusting the backlash of the final drive gears.

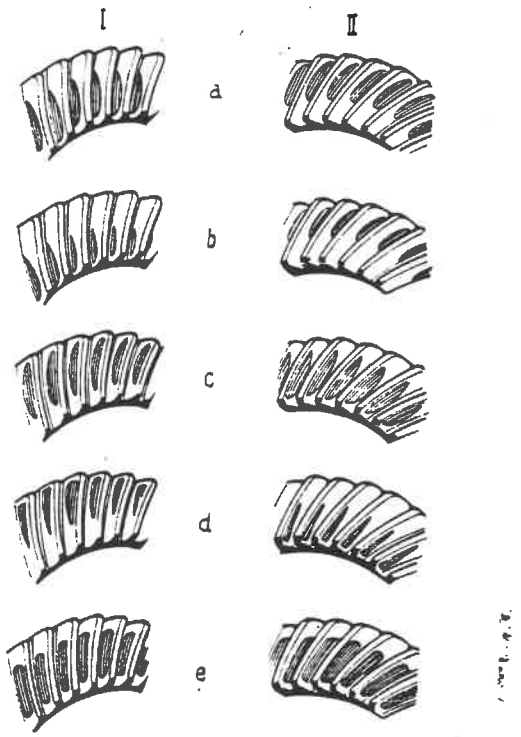


Fig.3-80. Tooth Contact of Final Drive Gears:
I - forward; II - reverse; a and b - wrong tooth contact: shift drive pinion away from ring gear by reducing thickness of adjusting ring; c and d - wrong tooth contact: shift drive pinion towards ring gear by increasing thickness of adjusting ring; e - correct tooth contact

Replacement of Drive Pinion Gland

The need for replacing the gland is symptomized by a drop of oil level in the rear axle housing caused by oil leakage through the gland so that functioning of the final drive becomes abnormal.

Sweating of the housing throat and even formation of separate oil drops not in excess of the below-stated number not be regarded as a symptom of leakage.

In case of intensive dripping, examine the gland as follows:

- put the car on a lift or an inspection pit;
- clean and inspect the breather;
- unscrew the level check plug and check oil level in the rear axle housing; bring the level to normal, if necessary;
- clean the housing throat of oil and wipe it dry;

- jack up the rear axle and put it on supports;

- start the engine, throw in the direct gear and run the stationary car at 90 - 100 km/h until the oil gets heated to 80 - 90 °C (it will take about 15 min);

- with the direct gear thrown in, at a speed of 100 km/h, determine the amount of oil leaking out in 15 min.

Oil leakage exceeding 5 drops in 15 min indicates that the gland is damaged.

The faulty gland can be replaced without removing the final drive from the car, provided the other final drive parts do not require replacement. To replace the gland proceed as follows:

- drain oil from the rear axle housing;

- loosen the rear wheel nuts, put chocks under the front wheels and jack up the rear axle; release the parking brake and set the gearshift lever in neutral;

- remove the wheels and brake drums;

- unscrew the nuts which hold the brake backing plate to the rear axle beam and withdraw the axle shafts from the differential case with a special knockout tool;

- disconnect the propeller shaft from the drive pinion flange and shift the shaft aside;

- using a dynamometer measure the antitorque moment of the drive pinion and note its value;

- holding the flange with a special wrench unscrew the drive pinion flange nut and remove the flange complete with the washer;

- take off the drive pinion gland;

- install a new gland using a mandrel without cocking; before installation, coat the working surfaces of the gland with Литол-24 grease;

-install the flange with the washer on the drive pinion and, holding it with a special wrench, tighten the flange nut, checking periodically with the dynamometer the antitorque moment of the drive pinion.

If the initial antitorque moment was 58.8 N.cm (6 kgf.cm) and higher, the new one should be 9.8 - 19.6 N.cm (1 - 2 kgf.cm) higher than the initial one. If, however, the initial antitorque moment was lower than 58.8 N.cm (6 kgf.cm), tighten the flange nut until the antitorque moment becomes 58.8 - 88.2 N.cm (6 - 9 kgf.cm).

If the nut is tightened to such an extent that the antitorque moment is higher than required, disassemble the final drive, replace the spacer sleeve by a new one, assemble the final drive and adjust as prescribed under previous Sub-Sections.

To assemble the rear axle reverse the disassembly operations.

FRONT AXLE

The design of the front axle is illustrated in Fig.3-81. A distinguishing paint mark "13" is made on the final drive housing.

Trouble Shooting

Cause	Remedy
Constant Loud Noise on the Move	
1. Wear or maladjustment of differential bearings	1. Replace worn parts, adjust differential bearings
2. Maladjustment, damage or wear of final drive gears or bearings	2. Identify cause of trouble, repair or replace final drive
3. Low oil level in front axle housing	3. Restore oil level, check for oil leaks through front axle housing seals
4. Wear or breakage of inner joint housing bearing	4. Replace bearing
Noise during Acceleration of Car or Engine Braking	
1. Meshing of final drive gears improperly adjusted during repairs	1. Adjust meshing of final drive gears as instructed under "Rear Axle"
2. Wrong backlash in final drive gears	2. Adjust backlash as instructed under "Rear Axle"
3. Excessively large clearance in drive pinion bearings caused by loosening of flange nut or wear of bearings	3. Adjust clearance (see "Rear Axle"); replace bearings, if necessary
Knocking at Beginning of Motion	
1. Wear of hole for pinion shaft in differential case	1. Replace differential case and, if necessary, pinion shaft
Oil Leaks	
1. Wear or damage of gland	1. Replace gland
2. Wear of inner joint housing gland	2. Replace gland
3. Loose fastenings of inner joint housing bearing covers or of axle housing covers, damaged sealing gaskets	3. Tighten nuts and bolts, replace sealing gaskets

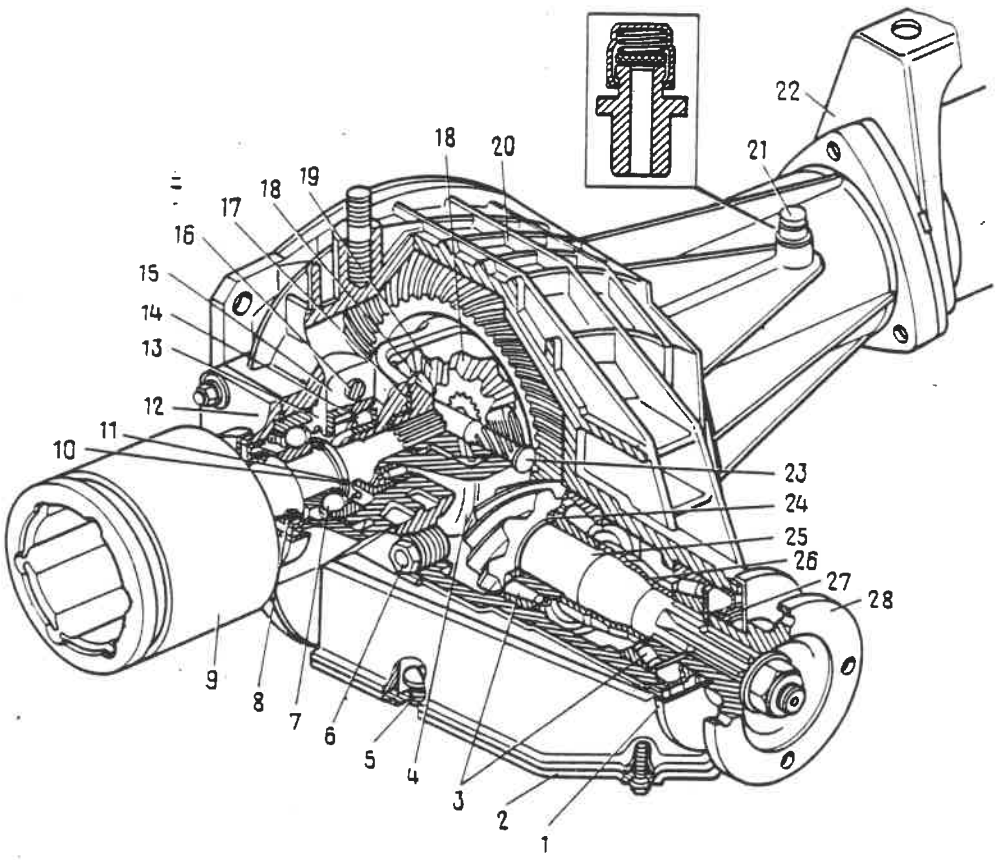


Fig.3-81. Front Axle:
1 - mud guard; 2 - final drive housing lower cover; 3 - drive pinion bearings; 4 - differential housing; 5 - drain plug; 6 - filler and level check plug; 7 - inner joint housing bearing; 8 - gland; 9 - wheel drive inner joint housing; 10 - spring washer; 11 - lock ring; 12 - bearing cover; 13 - adjusting nut; 14 - differential case bearing; 15 - bearing cover; 16 - cover bolt; 17 - supporting washer; 18 - axle-shaft gears; 19 - differential pinion; 20 - final drive housing; 21 - breather; 22 - front axle bracket; 23 - differential pinion shaft; 24 - adjusting ring; 25 - drive pinion; 26 - bearing spacer bushing; 27 - drive pinion gland; 28 - flange

Removal and Installation

Place the car on a lift or an inspection pit and raise its front end.

Remove the sway eliminator bar, the braces of the suspension crossmember and the protective shield of the engine sump. Disconnect the shock absorbers from the lower wishbones and detach the front propeller shaft from the drive pinion flange of the front axle final drive.

Compress the suspension spring, detach the ball joint from the lower wishbone and remove the spring, relieving it gently of the load. Disconnect the steering rods from the knuckle arms.

Take off the cap and unscrew the nut of the wheel hub bearings.

Perform the same operations on the other end of the suspension.

Loosen the clamp which holds together the inlet pipe and the muffler pipe, disconnect the pipe and muffler mountings in the rear end of the car and on the gearbox.

Using wrench 02.7812.9500, unscrew the nuts which fasten the muffler inlet pipe to the exhaust manifold and ease the pipe down.

Unscrew the nuts which fasten the engine front mount pads to the brackets of the front suspension crossmember.

Supporting the front axle, unscrew the bolt which fastens R.H. bracket 22 (Fig.3-81) to the engine and two nuts fastening the front axle at the L.H. side.

Lift the engine 25 - 30 mm and remove the front axle complete with the front wheel drive.

To install the front axle on the car, reverse the removal operations. During installation tighten the nuts and bolts with the torques specified in the Appendix 1.

Fill the front axle housing through the filler hole with transmission oil ТАД-17И; the oil level should reach the lower edge of the hole.

Disassembly

Install and fasten the front axle on a repair stand. Unscrew plug 5 (Fig.3-81) and drain oil from the housing, then do the following on both ends of the front axle:

- unscrew the nuts of cover 12 of inner joint housing bearing 7 and take out the joint taking care not to damage the gasket;
- remove lock ring 11 and spring washer 10, press bearing 7 off inner joint housing 9 and remove gland 8.

Take off the stamped cover of the axle housing and the sealing gasket. Lower cover 2 should not be removed.

Disassemble the front axle final drive, following the procedure described in the "Rear Axle" chapter.

Inspection

Examine the parts following the recommendations given in the "Rear Axle" chapter and, additionally, make sure that:

- the ball bearing of the inner joint housing is neither worn nor damaged (replace the bearing if its radial clearance exceeds 0.05 mm);
- the inner joint housing is not distorted and its mounting surfaces are not damaged;
- there are no scores and dents in the slots of the inner joint housing;
- neither wear nor cracks are seen on the housing mounting surfaces.

Replace any worn and damaged parts by new ones.

Assembly

Prior to assembling, refer to the marks on the final drive gears to make sure the gear ratio is equal to that of the rear axle final drive.

Assemble and adjust the front axle final drive in the manner prescribed in the "Rear Axle" chapter and see that distance "D" (see 3-79) is increased by 0.08 - 0.11 mm. To adjust the final drive, use bracket 67.8701.9508 with a measuring tip and wrench 67.7812.9520.

Install bearing cover 12 (Fig.3-81) with gland 8 on inner joint housing 9, then press-fit bearing 7. Install spring washer 10 and lock ring 11.

Note. The L.H. gland of the axle-shaft inner joint is provided with a distinguishing mark on the case in the form of a circular groove.

Install front axle bracket 22 together with the cover on the R.H. housing of the inner joint.

Install the assembled inner joint into the housing, first slipping sealing gaskets on the studs. Screw on the nuts of the joint bearing covers.

FRONT WHEEL DRIVE

Torque is transmitted to the front wheels from the front axle through the R.H. and L.H. drives, each consisting of shaft 4 (Fig.3-82) and two constant velocity universal joints.

The joints are mounted on the ends of shaft 4. The outer joint is connected with the front wheel hub; the joint is rigid, with angular degree of freedom of motion. The inner joint is of universal type, with angular and axial degree of freedom of motion. The joint is connected with the axle-shaft gear of the front axle. The outer joint consists of housing 13, holder 11, cage 8 with balls 10, lock ring 12 and thrust ring 7. Holder 11 is connected with housing 13 through the balls which enter the holder slots arranged radially, and the housing slots. The holder is slipped on the splines of shaft 4 all the way to bear against thrust ring 7 and is secured by lock ring 12. When compressed, this ring passes freely through the splined hole of holder 11 which contributes to easy connection and disconnection of the joint and shaft 4.

The joint is protected against ingress of dirt and moisture by boot 6 which, in its turn, is protected against mechanical damage by cover 5. The boot is held on shaft 4 and on the joint housing by clamp 9.

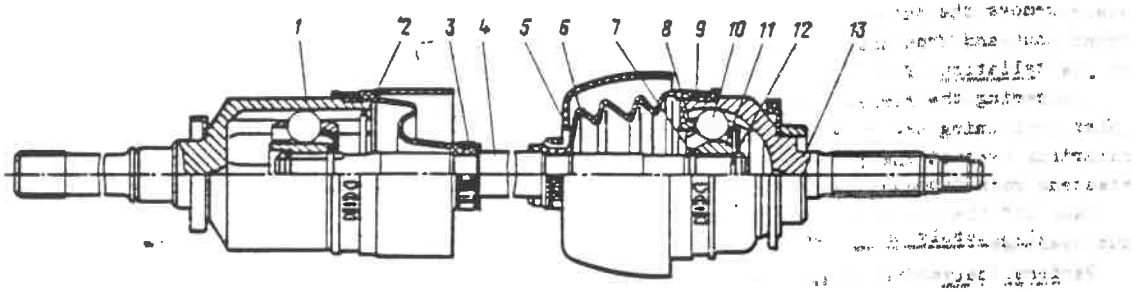


Fig.3-82. Front Wheel Drive:
1 - inner joint housing; 2 - retainer; 3 - boot ring; 4 - front wheel drive shaft; 5 - boot cover; 6 - boot; 7 - holder thrust ring; 8 - cage; 9 - clamp; 10 - ball; 11 - outer joint holder; 12 - lock ring; 13 - outer joint housing

The inner joint differs from the outer one in that it has straight slots. Axial displacement of the joint parts in the housing is limited by wire retainer 2.

The parts of the inner joint and some outer joints are divided according to size into several assembly groups; therefore, no single part of the joint may be replaced individually. The joint should be replaced as a unit. The parts that may be replaced separately are boot covers 5 and boots 6, clamps 9, ring 3 and retainer 2.

Trouble Shooting

Cause	Remedy
Noise and Knocking of Front Wheel on the Move (Particularly on Turns)	
1. Wear of outer or inner joint parts	1. Replace worn or damaged joints
2. Distortion of wheel drive shafts	2. Straighten or replace shafts
Leakage of Lubricant	
1. Damage or rupture of boots of inner or outer joints	1. Replace lubricant in joint and protective boot. If joint parts are worn or damaged, replace joint assembly

Removal and Installation

Removal. Put the car on a lift or inspection pit, apply the parking brake and perform the following operations on both sides of the car:

- raise the front end of the car and put supports under it;
- disconnect the shock absorber from the lower wishbone;
- compress the suspension spring and disconnect the ball joint from the lower wishbone;
- remove the wheel hub cap and unscrew the hub bearing nut, then the nuts of the inner joint housing bearing cover;
- unscrew the bolt of the front axle suspension R.H. bracket;
- remove the outer and inner joints from the wheel hub and from the front axle.

Installation. The front wheel drive is installed by reversing the removal operations.

When tightening the nuts of the front wheel hub bearings, adjust the clearance in the bearings as stated in the "Front Suspension" chapter.

Disassembly and Assembly

Disassembly. The front wheel drive must be disassembled in case of damage to boots 6 and covers 5 with a view to examining the parts of the joints and checking the quality of lubricant.

Proceed as follows:

- unclamp and remove clamp 9 (Fig.3-82) from rubber boot 6, and shift the cover with the boot along the shaft to ensure access to joint holder 11;
- knock holder 11 off the shaft with a drift and hammer;

Caution:

To prevent wedging of lock ring 12, take care not to cock the holder by selecting properly the force and direction of the blow.

- take thrust ring 7, boot 6 and cover 5 off shaft 4;
- shift the boot and cover of the inner joint along the shaft, remove retainer 2, take shaft 4 complete with the holder, cage and balls out of housing 1;
- knock the holder of the inner joint off shaft 4 with a drift and a hammer;
- take off the thrust ring and move the boot off the shaft;
- wash the inner spaces of the joint housings and other parts.

The most complicated and important are the operations related to disassembly and assembly of the outer joint whose parts are illustrated in Fig.3-83. Observance of the below-stated rules will ensure a high standard of disassembly and assembly.

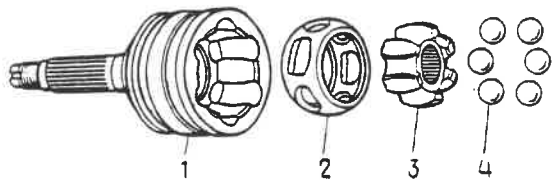


Fig.3-83. Front Wheel Drive Outer Joint Parts:
1 - joint housing; 2 - cage; 3 - holder; 4 - ball

Mark the holder, cage and housing of the joint with paint to define their relative positions. Clamp the outer joint in a vice as shown in Fig. 3-84. Incline the holder and cage so that one of the balls comes out as much as possible out of the slot in the joint housing. Force the ball with a soft-metal screwdriver out of the cage. Then turn all the parts so that the next adjacent ball comes to the same position, and remove it from the cage. Take out the remaining balls in the same manner. There can also be another sequence of removing the balls, viz., every other one.

It is permitted to strike the cage or holder gently with a tool made of a soft material. Do not exert too much force for turning the cage as this may cause locking of the balls and thus hamper further disassembly.

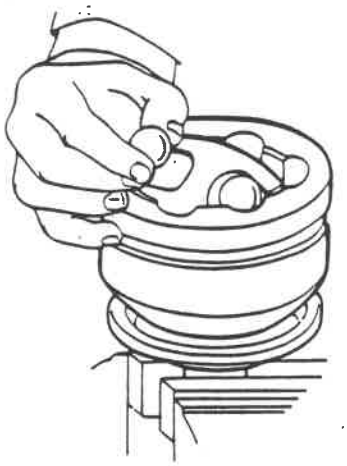


Fig.3-84. Removing Balls from Cage

Install the cage with the holder in such a manner that the elongated holes of the cage face the projections of the joint housing (Fig.3-85) and withdraw the cage complete with the holder.

Take the holder out of the cage; for this purpose, arrange one of the holder projections in the elongated hole of the cage (Fig.3-86) and then roll out the holder towards the straight edge of the hole. Wash and airblast all the parts of the joint.

Assembly. Assemble the outer joint in the order reverse to disassembly, bearing in kind the following:

- before assembly, coat all the parts with grease ШРУС-4;
- when installing the cage complete with the holder into the joint housing, align the marks made before disassembly and set the circular recess of the holder (for the thrust ring) so that it faces the shaft;
- while installing the balls into the cage, incline the holder to an angle approximately twice as large as that of the cage;
- fill the joint with 60 cm^3 of grease ШРУС-4;
- before striking shaft 4 (Fig.3-82) to connect it with inner holder 11, install new lock ring 12 strictly in the centre and then strike sharply at the end of the shaft down; the lock ring will compress and slide through the splined hole of the holder;
- to press-fit the ring of the joint housing gland, use mandrel 67.7853.9533.

After assembly, it may happen that the holder gets locked when the shaft is rocked and the ball does not rotate. This should not be regarded as improper assembly because there will be no such locking when the joint rotates in service.

Using the procedure described above disassemble the inner joint completely. The holder should be removed towards the larger diameter of the cage.

Assemble the inner joint by reversing the disassembly operations and aligning the marks made before disassembly. The elongated tapered part of the cage should face towards shaft 4.

During assembly pack the joint with 150 cm^3 of grease ШРУС-4.

Install the joint boots with mandrel 67.7853.9537.

If there is no knocking and vibration, and the boots are intact, the front wheel drive should better be left without disassembly.

Fig.3-85. Removing Cage Complete With Holder out of Joint Housing

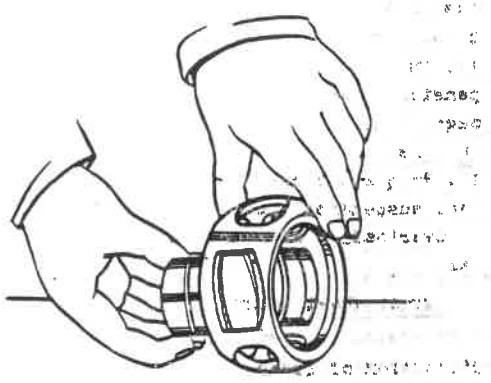


Fig.3-86. Removing Holder out of Cage

Section IV

RUNNING GEAR

TROUBLE SHOOTING

Cause	Remedy
Suspension Noisy and Knocking on the Move	
1. Shock absorbers faulty	1. Replace or repair shock absorbers
2. Loosening of sway eliminator bar bolts	2. Tighten sway eliminator bar bolts and nuts; replace rubber pads, if worn out
3. Wear of wishbone silent blocks	3. Replace silent blocks
4. Shock absorbers loosely fastened, or rubber bushes of their lugs are worn	4. Tighten bolts and nuts, replace bushes in shock absorber lugs
5. Wear of wishbone ball joints	5. Replace ball joints
6. Excessive clearance in wheel hub bearings	6. Adjust clearance or replace bearings
7. Heavy unbalance of wheels	7. Balance wheels
8. Deformation of wheel discs	8. Replace wheel discs
9. Spring weak or broken	9. Replace spring
10. Wear of rubber bushings of rear suspension radius rods	10. Replace bushings
11. Bumps of rear suspension caused by damage of compression buffers	11. Replace damaged buffers
12. Frequent bumps of rear suspension caused by overloading of rear axle	12. Relieve load on rear axle
Front Wheel Alignment Angles Fail to be Adjusted	
Distortion of lower wishbone shaft or wishbones	Replace shaft or wishbones
Car Pulls Sideways	
1. Non-uniform tyre pressure	1. Set correct tyre pressure in all wheels
2. Wrong front wheel alignment angles	2. Adjust wheel alignment angles

Continued

Cause	Remedy
3. Wrong clearances in front wheel bearings	3. Adjust clearances
4. Distortion of wishbones	4. Replace distorted wishbones
5. Non-uniform resilience of suspension springs	5. Replace weak spring
6. Incomplete release of wheel brakes	6. Correct defect
7. Considerable difference in wear of tyres	7. Replace worn tyres
8. Heavy unbalance of front wheels	8. Balance front wheels
9. Displacement of rear axle caused by deformation of rear suspension radius rods	9. Straighten out or replace radius rods
Front Wheel Shimmy	
1. Tyre pressure other than normal	1. Set correct tyre pressure
2. Excessive clearances in wheel hub bearings	2. Adjust clearances
3. Shock absorbers inoperative	3. Replace or repair shock absorbers
4. Loose nuts of ball joint pins	4. Tighten nuts
5. Wrong front wheel alignment angles	5. Adjust wheel alignment angles
6. Wear of wishbone shaft silent blocks	6. Replace silent blocks
7. Heavy unbalance of wheels	7. Check and balance wheels
8. Wear of wishbone ball joints	8. Replace joints
Frequent Suspension Bumps	
1. Weakening of suspension springs	1. Replace springs by new ones
2. Shock absorbers inoperative	2. Replace or repair shock absorbers
3. Distortion of wishbones	3. Replace distorted wishbones

Continued

Cause	Remedy
Excessive Clearance in Ball Joints	
Friction surfaces of ball joint parts worn which is caused by penetration of dirt through loose or damaged rubber boot	Replace ball joint and boot
Irregular Wear of Tyre Tread	
1. Excessive speed on turns	1. Reduce speed
2. Heavy wear of suspension joints and bushings	2. Repair suspensions
3. Unbalance of wheels (worn spots uniformly arranged over circumference, on extreme tread ribs or, after prolonged driving on unbalanced wheel, on central rib too)	3. Balance wheels
4. Non-uniform braking of wheels	4. Adjust brake system
5. Shock absorbers inoperative	5. Replace or repair shock absorbers
6. Wrong camber (wear of tread inner ribs)	6. Adjust wheel camber
7. Underinflated tyres (heavy wear on extreme ends of tread)	7. Inflate tyres as required
8. Overinflated tyres (heavy wear of central tread rib)	8. Inflate tyres as required
9. Insufficient toe-in of front wheels (wear of tread inner ribs)	9. Adjust toe-in
10. Excessive toe-in of front wheels (wear of tread outer ribs)	10. Adjust toe-in
Wheels Wobble	
1. Wrong balancing of wheels:	1. Do the following:
- non-uniform wear of tyre tread over circumference	- balance or replace wheels
- shifting of balance weights and tyres during mounting	- balance wheels
- deformation of wheel rim	- true up or replace rim; balance wheels
- damaged tyres	- replace tyre and balance wheel
2. Excessive clearance in wheel hub bearings	2. Adjust clearance

Continued

Cause	Remedy
Fluid Leaks from Shock Absorber	
1. Wear or damage of rod gland	1. Replace gland
2. Foreign hard particles get on gland sealing edges	2. Wash shock absorber parts, change or filtrate fluid
3. Nicks, notches, scores on rod; complete wear of chromium coating	3. Replace worn or damaged rod and gland
4. Loosening of reservoir nut	4. Tighten up nut
5. Reservoir damaged in sealing ring zone	5. Replace or repair repair reservoir
6. Reservoir sealing ring shrunk or damaged	6. Replace ring
7. Too much fluid in shock absorber	7. Adjust amount of fluid
Insufficient Resistance of Shock Absorber During Rebound Stroke	
1. Poor tightness of rebound or bypass valve	1. Replace or repair faulty valve parts
2. Piston ring broken or stuck in groove	2. Replace ring or eliminate its sticking
3. Lack of fluid caused by leaks	3. Replace faulty parts and fill shock absorber with fluid
4. Piston or cylinder scored	4. Replace damaged parts, change fluid
5. Wear of hole in guide bushing	5. Replace guide bushing
6. Fluid contaminated with mechanical impurities	6. Wash all parts, change fluid
7. Weakening of rebound valve spring	7. Replace spring
Insufficient Resistance of Shock Absorber During Compression Stroke	
1. Poor tightness of compression valve	1. Replace or repair damaged parts
2. Lack of fluid due to leaks	2. Replace damaged parts, fill fluid
3. Wear of guide bushing and rod	3. Replace worn parts by new ones
4. Fluid contaminated with mechanical impurities	4. Wash all parts, change fluid
5. Wear or damage of compression valve discs	5. Replace damaged parts
Shock Absorber Knocks and Squeaks	
1. Wear of rubber bushes in lugs	1. Replace bushes

Continued

Cause	Remedy
2. Deformation of dust shield caused by impacts	2. Replace or repair dust shield
3. Lack of fluid caused by leaks	3. Replace damaged parts, fill fluid
4. Loosening of reservoir and piston nuts	4. Tighten up nuts
5. Jamming of rod caused by deformation of cylinder, reservoir or rod	5. Replace or true up defective parts
6. Loosening of shock absorber fastening nuts	6. Tighten up nuts
7. Breaking of shock absorber parts	7. Replace damaged parts by new ones
Heavy Wear of Tyre Tread	
1. High speed motoring	1. Choose correct speed to suit road conditions
2. Excessively sharp accelerations	2. Avoid sharp accelerations
3. Unduly frequent use of brakes	3. Use brakes skillfully

Continued

Cause	Remedy
4. Wrong front wheel alignment angles	4. Adjust angles
5. Excessive clearances in wheel hub bearings	5. Adjust clearances
6. Car overloaded	6. Do not overload car above limits indicated in operating instructions
7. Failure to interchange wheels as recommended in operating instructions	7. Interchange wheels as recommended in operating instructions
Tyres Squeal on Turns	
1. Wrong tyre pressure	1. Set correct tyre pressure
2. Wrong front wheel alignment angles	2. Adjust angles
3. Distortion of suspension wishbones, crossmember or body front end parts	3. Replace distorted parts, straighten body front end parts

FRONT SUSPENSION

The design of the front suspension is shown in Fig.4-1.

Inspection of Front Suspension Parts

During each round of maintenance and repairs, make sure to examine the boots of the suspension ball joints, paying particular attention to absence of mechanical damage. Scrutinize the suspension parts carefully for cracks, signs of rubbing against road obstacles or car body, distortions of the lower wishbone shafts, crossmember or suspension wishbones and body front end parts and check the condition of the ball joints and silent blocks.

Distortion of the lower and upper wishbone shafts is revealed visually.

Distortion of the front suspension crossmember is determined by measuring the distance between the outer surfaces of the crossmember brackets in the zone of the upper wishbone shaft fastening bolts. This distance should be (736±1.5) mm.

If the crossmember is distorted to such an extent that the wheel alignment angles cannot be adjusted properly with washers, though the other components of the suspension are in order, replace the crossmember.

The silent blocks should be examined as follows:

- make sure there is no deformation of the suspension wishbones, lower wishbone shaft, and suspension crossmember; then jack up the front wheels of the car;
- measure radial displacement A (Fig.4-2) of outer bushing 2 relative to inner bushing 6 and distance B between thrust washer 5 and the outer face of outer bushing 2.

The silent blocks of the upper and lower wishbones must be replaced in the following cases:

- when rubber is fractured or bulged on one side;
- if rubber is undercut and worn on silent block faces;
- if radial displacement A of the outer bushing relative to the inner one exceeds 2.5 mm;
- if size B goes out of 3 - 7.5 mm limits.

If size B goes beyond the above-specified limits, check silent block position in the wishbone socket.

The clearance in the upper ball joints should be checked as follows:

- put the car on a level horizontal hard-surface floor;
- jack up the R.H. (L.H.) front side of the car and take off the wheel;
- put a wooden block 230 mm high under the lower wishbone nearer to the ball pin and ease down the car on the block;
- make sure that resin does not ooze out of the hole in the upper ball pin housing; if neces-

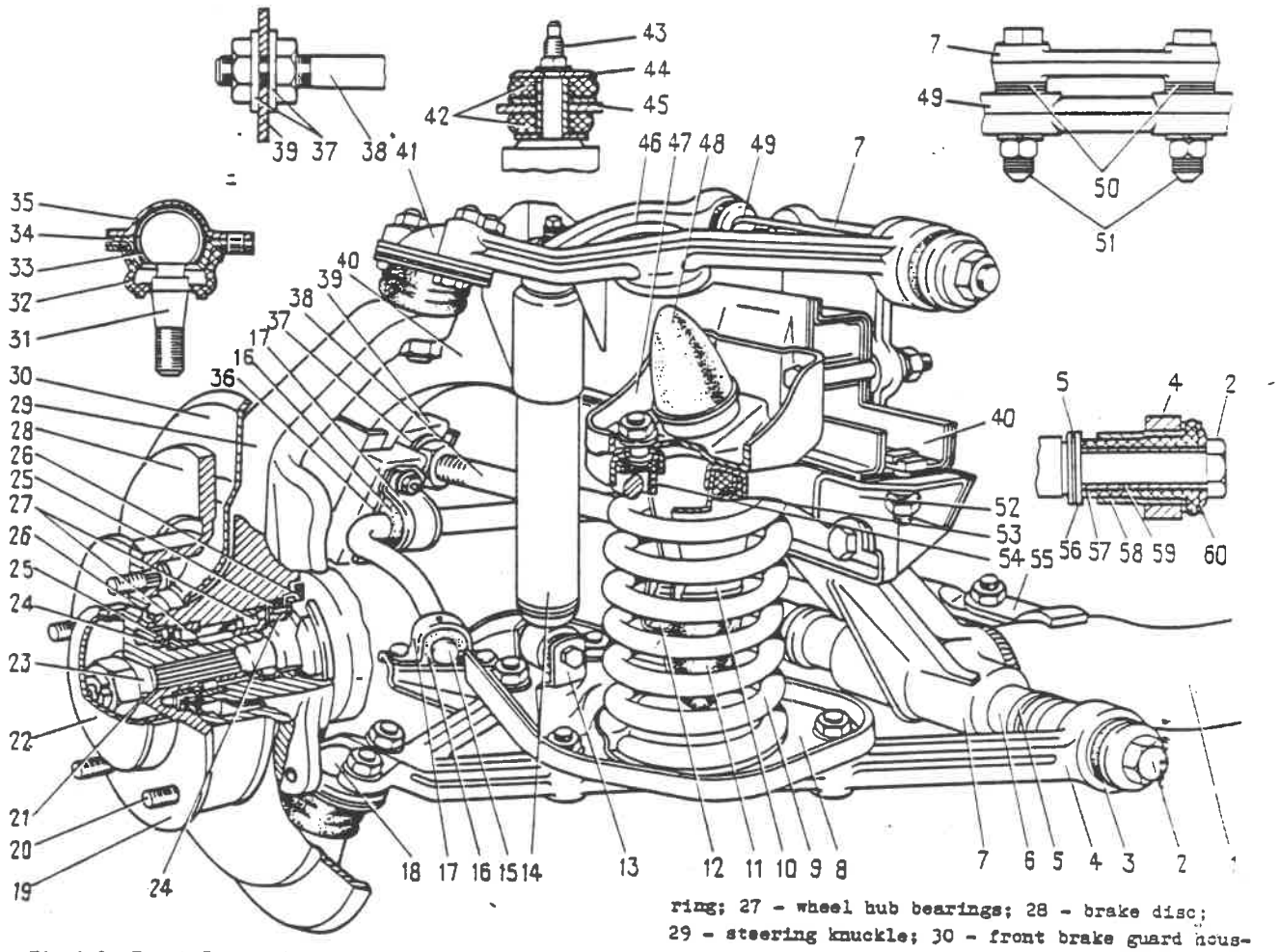


Fig.4-1. Front Suspension:
1 - front suspension crossmember; 2 - lower wishbone shaft; 3 - lower wishbone silent block; 4 - lower wishbone; 5 - lower wishbone adjusting washers; 6 - lower wishbone shaft bushing; 7 - crossmember bracket; 8 - suspension spring lower seat; 9 - suspension spring; 10 - compression stroke buffer support post; 11 - compression stroke buffer; 12 - compression stroke stop; 13 - shock absorber lower bracket; 14 - shock absorber; 15 - sway eliminator bar; 16 - rubber pad; 17 - sway eliminator bar holder; 18 - lower ball joint; 19 - wheel hub; 20 - brake disc and wheel bolt; 21 - tapered bushing; 22 - cap; 23 - outer constant velocity universal joint housing extension; 24 - gland bushing; 25 - gland; 26 - mud deflecting ring; 27 - wheel hub bearings; 28 - brake disc; 29 - steering knuckle; 30 - front brake guard housing; 31 - ball joint pin; 32 - boot; 33 - bearing; 34 - ball pin seat holder; 35 - ball pin bearing housing; 36 - sway eliminator bar fastening plate; 37 - washers; 38 - tension member; 39 - tension member bracket; 40 - body side member; 41 - upper ball joint; 42 - shock absorber rod pad; 43 - shock absorber rod; 44 - washer; 45 - shock absorber bracket; 46 - suspension upper wishbone; 47 - rebound stroke buffer bracket; 48 - rebound stroke buffer; 49 - suspension upper wishbone shaft; 50 - adjusting washers; 51 - upper wishbone shaft bolts; 52 - suspension spring upper support; 53 - suspension spring upper seat; 54 - spring insulating gasket; 55 - tension member-to-crossmember bracket; 56 - thrust washer; 57 - rubber bushing; 58 - outer bushing; 59 - inner bushing; 60 - thrust bushing

sary, remove it with a file to prevent measurement errors;

- secure indicator bracket 4 (Fig.4-3) on the upper end of the steering knuckle;

- set indicator 2 in the centre of the sphere of upper ball joint housing 3 with a slight pretension and then align the zero mark of the indicator with the pointer;

- secure 0.7 mm long forked lever 5 on the upper wishbone of the front suspension;

- build up a load of 196 N.m (20 kgf.m) in the vertical direction with torque-indicating wrench 6 (294 N on the end of the forked lever) first for pushing the ball pin into, then for pulling it out of, the joint housing;

- record the respective maximum deflections of the indicator pointer;

- calculate the values of the clearance in the upper ball joint by summing up the values of deviation from zero;

- the summary readings of the indicator should not exceed 0.8 mm.

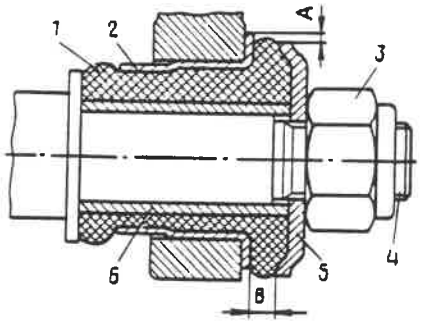


Fig.4-2. Examining Front Suspension Wishbone Silent Block:
1 - rubber bushing; 2 - outer bushing; 3 - shaft nut; 4 - wishbone shaft; 5 - thrust washer; 6 - inner bushing

Front Wheel Check and Alignment

The front wheel alignment angles should be checked and adjusted on special stands following their Operating Instructions.

Caution:

The checks of the wheel alignment angles are mandatory after replacement or repairs of the suspension parts which may disturb the angle settings.

Check and adjust the wheel alignment angles on a car under a static load of 3140 N (320 kgf) which corresponds to the weight of four men and a load of 40 kg in the trunk.

The alignment angles should be as follows:

- camber $0^{\circ}30' \pm 20'$;
- caster $3^{\circ}30' \pm 30'$;
- toe-in 3 ± 1 mm.

Prior to adjustment, check the following:

- tyre pressure;
- axial clearance in front wheel hub bearings;
- condition of shock absorbers (absence of rod jamming);
- radial and axial wobble of tyres;
- clearance in suspension ball joints;
- steering wheel play.

Eliminate defects, if any, and make necessary adjustments.

After installing the car on a stand, just before checking the alignment angles, "pump" the car suspension by pushing down first the rear bumper, then the front bumper two or three times with a force of 392 - 490 N (40-50 kgf).

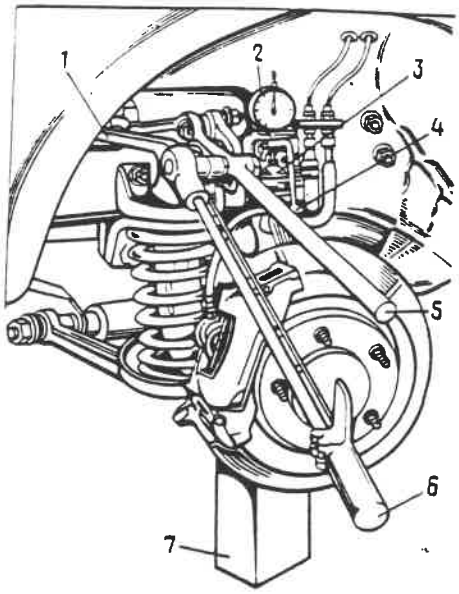


Fig.4-3. On-Car Checks of Clearance in Suspension Upper Ball Joints:
1 - upper wishbone; 2 - indicator; 3 - upper ball joint housing; 4 - indicator bracket; 5 - lever; 6 - torque-indicating wrench; 7 - block

The sequence of adjustments should be as follows:

1. Caster
2. Camber
3. Toe-in.

Caster. If the measurements show that the caster angle comes out of the above-specified limits, change the number of adjusting washers 50 (Fig.4-1) installed between the upper wishbone shaft and the crossmember bracket (see Table 4-1).

Table 4-1

Adjustments of Camber and Caster by Washers

Number of washers added or removed		Camber	Caster
front bolt	rear bolt		
+1	+1	+(8'42")	0
-1	-1	-(8'42")	0
+1	0	-(7'30")	+(20'24")
-1	0	+(7'30")	-20'24")
0	+1	+(15'18")	-(25'18")
0	-1	-(15'18")	+(25'18")
-1	+1	+(27'30")	-(43'18")
+1	-1	-(21'36"1	+(40')

Note. These data are true for washers 0.75 mm thick. The sign "plus" or "minus" means that a washer must be added or removed, respectively.

To adjust the caster angle:

- unscrew the nuts holding the upper wishbone shaft and transfer the washers from one bolt to the other until the angle is as prescribed. The caster angle inscreases when the washers are transferred from the rear bolt to the front one and vice versa;
- turn on the nuts with a torque-indicating wrench and check for correct caster angle.

Camber angle. If the camber angle is other than normal, adjust it by changing the number of washers 50 (Fig.4-1) installed between the upper wishbone shaft and the crossmember bracket.

To decrease (increase) the camber angle, remove (add) number of washers on both bolts.

Toe-in of front wheels. If the toe-in is other than normal, loosen the clamps of the side rods and turn both sleeves with wrench 67.7813.9504 through the same angle in opposite directions; in this manner the sleeves are turned on or off, thus changing the length of the side steering rods.

On completion of adjustment, install the clamps with their slots facing backwards, with maximum tolerable tilting of 60° to the horizontal plane. With the nuts tightened, the edges of the clamp slots should not meet.

Having adjusted the toe-in, check to see that the wheels and the parts of the steering linkage do not rub against the adjacent parts of the suspension and body. For this purpose, turn the wheels all the way back and forth until the pitman arm comes to bear against the bolts of the steering gear case.

Checks and Adjustment of Clearances in Front Wheel Hub Bearings

To check the clearance, remove the cap, loosen the wheel nuts, then jack up the front end of the car, put it on a support and remove the front wheel.

Remove the front brake caliper with brake shoes. See that the caliper does not hang down from the H.P. hoses.

Fasten gauge 67.7834.9507 with an indicator (Fig.4-4) to the steering knuckle so that the indicator rod bears against the wheel hub as near to the adjusting nut as possible. Turning the hub back and forth, move it with lever 67.7820.9521 along the steering knuckle axis (forward and back). Measure the displacement (clearance) with the indicator.

If the clearance is larger than 0.15 mm, adjust it as follows:

- turn off the adjusting nut from the outer joint housing extension;
- install a new nut or a used nut from another car and turn it on with a torque of 19.6 N.m (2 kgf.m), rotating at the same time the hub back and forth two or three times to allow the bearing rollers to seek their proper places;
- loosen the adjusting nut and tighten it up again with a torque of 6.86 N.m (0.7 kgf.m);
- make mark B on the washer (Fig.4-5), then back off the nut through 20 - 25° until the first edge A gets in line with the mark;
- lock the nut in this position by forcing the projections on the neck into the slots in the end of the outer joint holder extension.

After adjustments the clearance in the bearing should range from 0.01 to 0.07 mm.

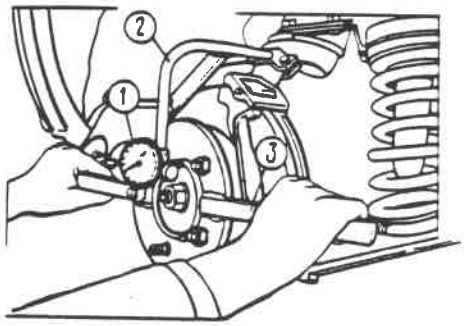


Fig.4-4. Checking Axial Clearance in Front Wheel Hub Bearings:
1 - indicator; 2 - gauge 67.7834.9507; 3 - lever 67.7820.9521

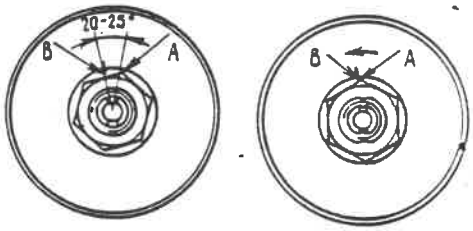


Fig.4-5. Tightening and Adjusting Front Wheel Hub Bearings:
A - nut edge; B - mark on washer

Replacement of Grease in Front Wheel Hub Bearings

Do the following on both sides of the car:

- jack up the front end of the car and remove the wheel;
- unbend the edges of the brake front guard, unscrew the bolts of the brake shoe guide and take the brake caliper off the brake disc, shifting it aside. Do not disconnect the brake hoses so as to prevent ingress of air into the hydraulic system and see that the caliper does not hang on the hoses;
- using remover tool 67.7823.9514, remove the cap from the wheel hub, unscrew the adjusting nut and remove bushing 21 (Fig.4-1);
- taking care not to damage gland 25, remove hub 19 complete with the brake disc;

- put a support under lower wishbone 4 and ease down the front end of the car a little so as to compress spring 9;

- disconnect lower ball joint 18 from the wishbone;

- detach shock absorber 14 from lower wishbone 4 and the side steering rod from the arm of steering knuckle 29;

- shift the front wheel drive shaft all the way towards the front axle;

- turning steering knuckle 29 relative to upper ball joint 42 remove the knuckle from universal joint housing extension 23;

- using handle 67.7853.9535 with washer 67.7853.9540, press the inner races of bearings 27 complete with dismantling rings and glands 25 out of the steering knuckle space. Press out the outer races of the bearings using washer 67.7853.9534 and press them in with the aid of mandrel 67.7853.9536. Mark the bearing races so as to install them back where they belong;

- remove the old lubricant and wash with kerosene the inner space of the steering knuckle, outer and inner spaces of the hub, constant velocity universal joint housing extension and bearings;

- pack 40 g of fresh grease Литол-24 into the bearing cages, apply grease in a uniform layer to the steering knuckle spaces between the bearings and lubricate the splines of the joint housing extension;

- install the bearing inner races, the dismantling rings and press-fit the glands;

- put the steering knuckle on the extension of the universal joint housing and connect the ball joint to the lower wishbone;

- secure the shock absorber and connect the side steering rod to the knuckle arm;

- install the hub complete with the brake disc on the joint housing extension and install tapered bushing 21;

- screw on a new adjusting nut and adjust the clearances in the wheel hub bearings;

- install the wheel hub cap with mandrel 67.7853.9528;

- put in place the brake caliper and the wheel.

Note. In all cases when the nut has been removed from the extension of the outer joint housing, replace it by a new one or use a nut removed from another car.

Balancing of Wheels

The wheels should be balanced in special stands in accordance with the stand Operating Instructions. The unbalance can be eliminated by the use of balance weights held on the wheel rim by special springs.

Removal and Installation of Front Suspension

Place the car on a lift or an inspection pit, apply the parking brake, open the hood and remove the spare wheel.

Put chocks under the rear wheels and remove the front ones.

Using remover 67.7824.9516 (see Fig.5-10), press the pins out of the steering knuckle arms and shift aside the steering rods.

Disconnect sway eliminator bar 6 (Fig.4-6) from the suspension lower wishbones.

Disconnect tension members 5 from the body brackets and crossmember.

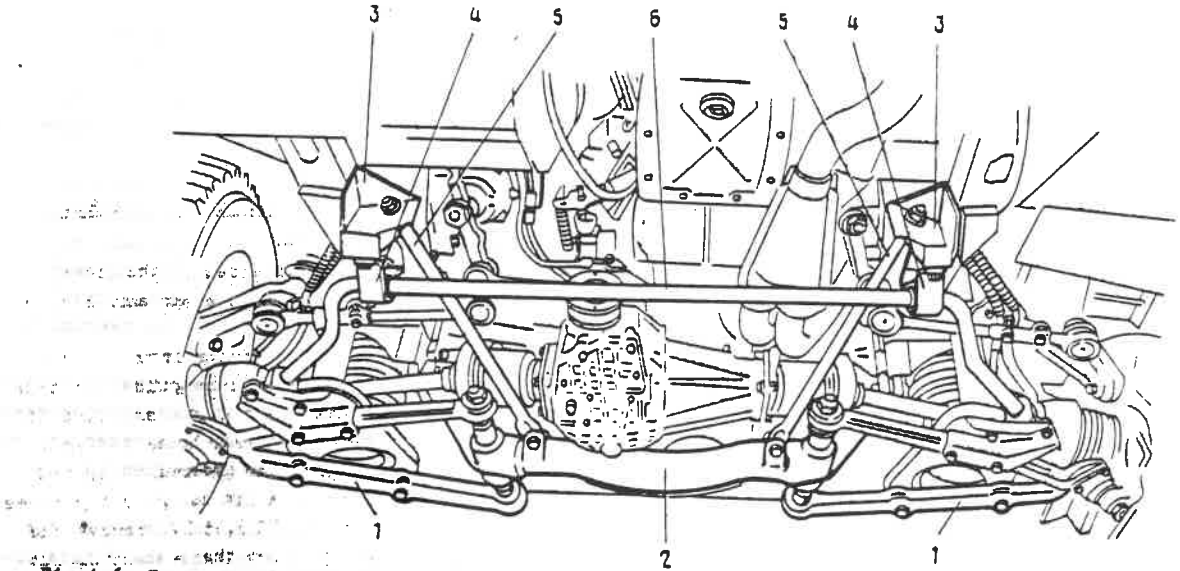


Fig.4-6. Front Suspension Mounted on Car (Rear View):
1 - lower wishbone; 2 - crossmember; 3 - tension member bracket; 4 - sway eliminator bar-to-body bracket; 5 - tension member; 6 - sway eliminator bar

Detach the shock absorbers from the suspension lower wishbones.

Remove the engine sump protective shield and the splashboard.

On each side of the car remove the front brake caliper without disconnecting the brake hoses and suspend it so that it does not hang on the hoses.

Compress the suspension spring to relieve completely the lower wishbone.

Disconnect the ball joint from the lower wishbone and take off the spring, relieving it gently; repeat the same operations on the other suspension unit.

Disconnect upper wishbone shaft 49 (Fig.4-1) from suspension crossmember bracket 7 and remove upper wishbone 46 complete with the steering knuckle, wheel hub, front brake and outer joint housing.

Note. When removing the upper wishbone shaft, take a note of the number and location of the washers between the upper wishbone shaft and the crossmember and of the adjusting plates between the crossmember and the body side member so as to return the washers and plates to their previous places during reassembly.

Disconnect the engine mount rubber pads from the crossmember brackets.

Put a hydraulic jack with a fixing device under the suspension crossmember and, supporting the engine with cross beam 67.7820.9514 or a hoist, detach the suspension crossmember and bracket 47 of the rebound buffer from the body side member.

Take off crossmember 1 complete with lower wishbones 4.

Install the suspension units and parts in the reverse order of removal operations. The suspension springs should belong to the same class (class A - unmarked, class B - black marks on the coil outer surface). It is permissible to install class A springs in the front suspension if class B springs are installed in the rear suspension.

Having assembled and installed the suspension, check the wheel alignment angles and toe-in.

Disassembly and Assembly of Front Suspension Units

Disassembly. If the suspension repairs call for a complete stripping of its units, this should better be begun directly on the car, after removing the sump protective shield and the splashboard.

Proceed as follows:

- unscrew the nut of the pin of upper ball joint 41 (Fig.4-1) and free the hoses from the clips;

- unbend the tongues of the guard, turn out the bolts of the caliper guide and shift it aside complete with the caliper;

Caution:

To protect the hoses against damage, see that the caliper does not hang on them.

- using remover 67.7823.9514, take off the hub cap and unscrew the nut of the wheel hub bearings;
- remove the front wheel hub complete with the brake disc using remover 67.7823.9516;
- remove the guard of the front brake;
- remove the front suspension shock absorber;
- compress the suspension spring to relieve completely the lower wishbone, easing the wishbone down on a support;
- disconnect the ball joint housings from the suspension lower and upper wishbones and remove the steering knuckle;
- relieve gently and remove the suspension spring;
- using remover 67.7823.9515, knock out the shaft and disconnect the lower wishbone from the crossmember;
- disconnect the upper wishbone shaft from the crossmember and take off the shaft complete with the wishbone;

Note. Before removing the shafts of the upper and lower wishbones, count the number of washers on each end of the lower wishbone shaft and on the bolts of the upper wishbone shaft so as to put them in their own places during reassembly.

- remove the crossmember and the rebound buffer bracket as described above;
- using remover 67.7824.9516, press the ball joint pins out of the steering knuckle holes.

The parts of the front suspension are shown in Fig.4-7.

Assembly of the front suspension units is carried out in the reverse order of disassembly operations. When assembling the wheel hub, put a layer of LITOL-24 grease into the bearing cages and apply a uniform layer of this grease into the steering knuckle space between the bearings, 40 g per knuckle.

When installing the crossmember tension members, screw on the inner nut until the clearance between the washer and bracket 3 (Fig.4-6) is taken up; turn on the outer nut with a torque specified in the Appendix 1.

To avoid wrong distribution of forces in the silent blocks, turn on the wishbone shaft nuts under a static load of the car equal to 3140 N (320 kgf). Then check and adjust the wheel alignment angles and toe-in.

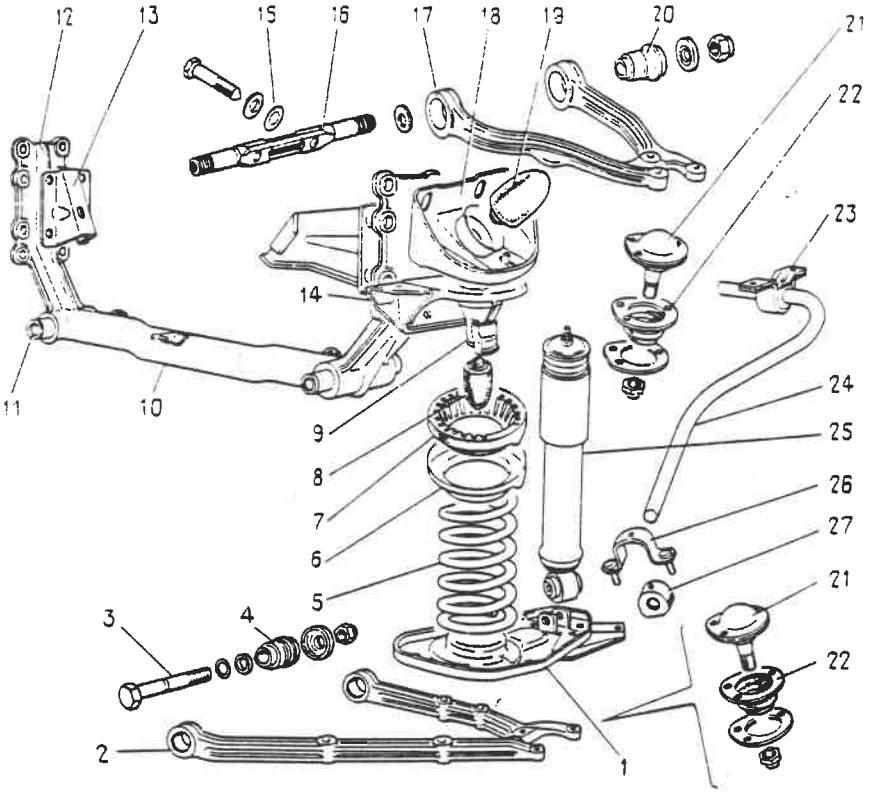


Fig.4-7. Front Suspension Parts:
1 - suspension spring lower seat; 2 - lower wishbone; 3 - lower wishbone shaft; 4 - lower wishbone silent block; 5 - spring; 6 - upper seat; 7 - spring insulating gasket; 8 - compression stroke buffer; 9 - compression stroke stop; 10 - suspension crossmember; 11 - crossmember bracket bushing; 12 - crossmember bracket; 13 - engine mount bracket; 14 - spring upper support; 15 - adjusting washer; 16 - upper wishbone shaft; 17 - upper wishbone; 18 - rebound stroke buffer bracket; 19 - rebound stroke buffer; 20 - upper wishbone silent block; 21 - ball joint; 22 - ball joint boot; 23 - bar-to-body bracket; 24 - sway eliminator bar; 25 - shock absorber; 26 - pad holder; 27 - pad

Inspection

Ball joints. Make sure that the ball joint boots are intact; they should be free of such defects as fractures, cracks, separation of rubber from metal and leakage of lubricant.

Examine the working surfaces of the ball joints for wear, turning the ball pin by hand. Play or jamming of the pin are impermissible.

The condition of the ball joint can be assessed more accurately by the amount of radial and axial clearances measured with gauge 02.8701.9502. For this purpose install ball joint 1 (Fig.4-8 A) into the gauge socket and clamp it with a screw. Place indicator 2 into the gauge bracket with the indicat rod bearing against the side surface of the joint housing, and the indicator pointer at zero.

Insert torque-indicating wrench 3 into the upper socket of the gauge and, applying a torque of 196 N.m (20 kgf.m) in both directions, read the summary radial clearance in the ball joint from indicator 2. If the clearance is larger than 0.7 mm, replace the ball joint by a new one.

Measure the axial clearance in the ball joint in the same manner, first having changed its fastening in the gauge as shown in Fig.4-8 B. The maximum permissible axial clearance in the joint is not over 0.7 mm.

Suspension springs. Examine the springs thoroughly and replace them by new ones if the nature of deformations may render them unfit for further service.

Compress the spring three times until its coils close and check its resilience by the reference points (Fig.4-9).

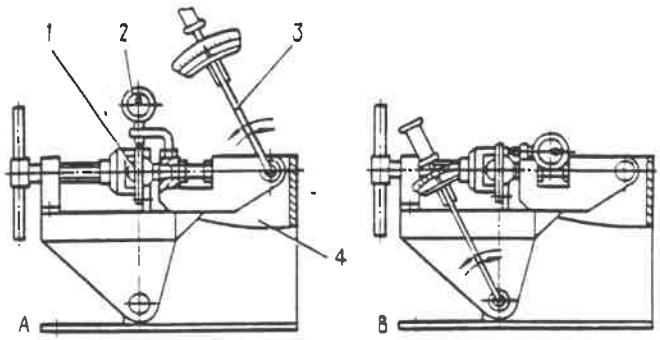


Fig.4-8. Checking Ball Joint on Gauge 02.8701.9502:
1 - ball joint; 2 - indicator; 3 - torque-indicating wrench; 4 - gauge 02.8701.9502;
A - checking radial clearance; B - checking axial clearance

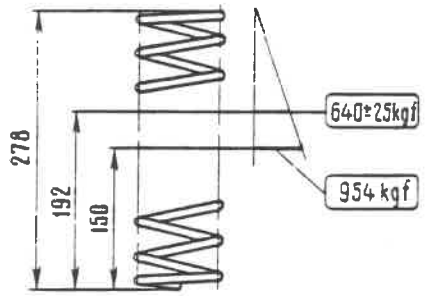


Fig.4-9. Main Data for Checking Front Suspension Spring

Examine the insulating gaskets and replace them, if necessary.

Sway eliminator, wishbones, steering knuckle. Check the sway eliminator bar for distortion and make sure that its ends are in one plane. Straighten out the bar if distortion is slight or replace it, if heavy.

Make a close examination of the wishbones, crossmember and steering knuckels to see that they are neither distorted nor cracked.

Replace cracked and distorted parts.

Front suspension crossmember. Check the geometrical parameters of the crossmember with gauging mandrel 67.8732.9501. If the crossmember is badly distorted and the front wheel alignment angles cannot be adjusted properly by washers, though all the other suspension elements are intact, replace the crossmember.

Silent blocks. The necessity for replacing the silent blocks is determined in "Inspection of Front Suspension Parts".

Replacement of Silent Blocks

Upper wishbone. Install fixture 67.7823.9527 on the shaft between the wishbone lugs and place the wishbone on mandrel A.47045 (Fig.4-10). Apply the press punch to wishbone shaft 1 until silent block 3 is pressed out of the hole. To press out the other silent block, turn the wishbone over and repeat the same operation.

The silent blocks of the upper wishbones are press-fitted with the aid of fixture 67.7853.9519 (Fig.4-11) clamped in a vice. Place the wishbone with shaft 1 on fixture 2, put the silent block on the shaft and drive it into the wishbone socket with installation tool 3 (A.74177/1). Then repeat the same operations for press-fitting the other silent block on the other side of the wishbone.

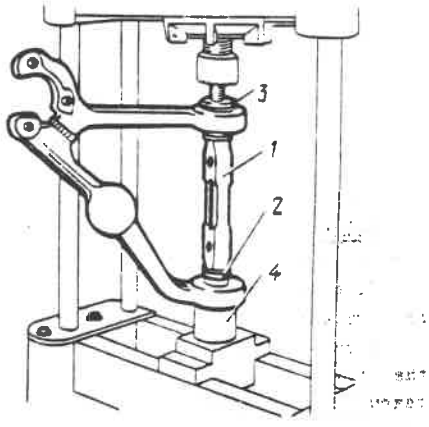


Fig.4-10. Pressing Out Upper Wishbone Silent Blocks:
1 - wishbone shaft; 2, 3 - silent blocks;
4 - installation tool A.74177/1

Lower wishbone. The silent block can be driven in and out either in a press with the aid of fixture 67.7823.9526 or using fixture 67.7823.9517 (Fig.4-12) installed on the wishbone, with the head of the fixture screw facing inward. Press out the silent block by turning in the screw.

To press-fit, insert the silent block into the wishbone socket and install fixture 67.7823.9517 (Fig.4-13) together with cap 3. Turning in the fixture screw, press-fit the silent block into the wishbone socket.

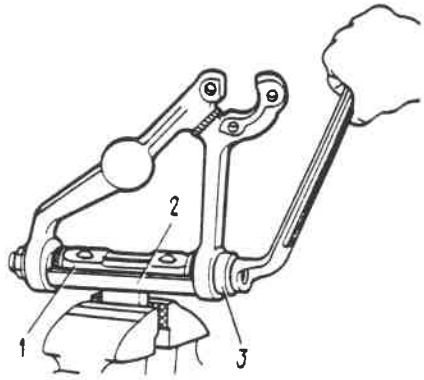


Fig.4-11. Press-Fitting Upper Wishbone Silent Blocks:
1 - wishbone shaft; 2 - fixture 67.7853.9519; 3 - installation tool A.74177/1

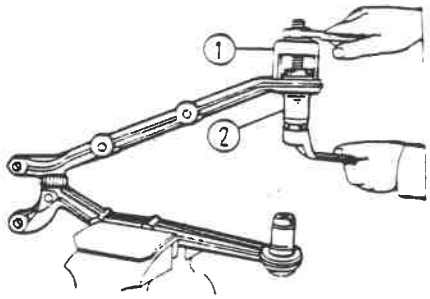


Fig.4-12. Pressing Out Lower Wishbone Silent Blocks:
1 - fixture 67.7823.9517; 2 - silent block

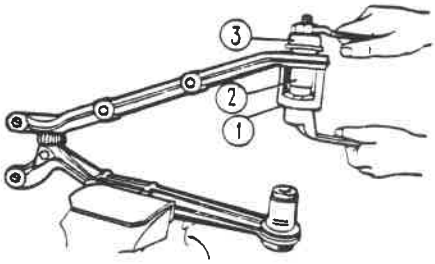


Fig.4-13. Press-Fitting Lower Wishbone Silent Blocks:
1 - fixture; 2 - silent block; 3 - cap

REAR SUSPENSION

The design of the rear suspension is shown in Fig.4-14.

Removal and Installation

Removal. Jack up the rear end of the car and put it on supports. Remove the rear wheels.

Disconnect the propeller shaft from the final drive pinion flange.

Disconnect the hydraulic brake hose from the steel pipe mounted on the axle and take measures to prevent fluid leaks from the brake system.

Disconnect the brackets of the parking brake rear cable from the car body, take off the front cable return spring end, unscrewing the locknut and the adjusting nut, free the rear cable. Disconnect rod 13 (Fig.4-14) of the rear brake pressure regulator from the bracket on the axle beam. Disconnect the upper ends of shock absorbers 25.

Put a hydraulic jack under the rear axle beam. Disconnect longitudinal (3, 17) and transverse (24) radius rods from the brackets on the body, then lower the jack and remove the rear axle.

Proceed with disassembling the suspension:

- remove the shock absorbers from the brackets on the rear axle beam;
- disconnect the longitudinal and transverse radius rods from the brackets on the rear axle beam.

The parts of the rear suspension are shown in Fig.4-15.

Installation. To install the rear suspension reverse the removal operations.

The springs of the rear suspension should belong to the same class as those used in the front suspension. In exceptional cases, when class A (unmarked) springs are used in the front suspension and such springs are not available for the rear suspension, class B springs (marked black) may be used. If the front suspension has class B springs, the rear suspension must have only class B springs too.

To avoid damaging and overtightening of the flexible bushings of the radius rod joints and shock absorbers:

- load the rear end of the car so that distance "X" from the axle beam to the body side member measured at a point located 100 mm from the transverse radius rod bracket (Fig.4-16) is 152 mm;
- using a torque-indicating wrench, tighten the nuts of the bolts of the longitudinal and transverse radius rods, also the nuts of the pins which fasten the shock absorbers to the axle beam and the car body.

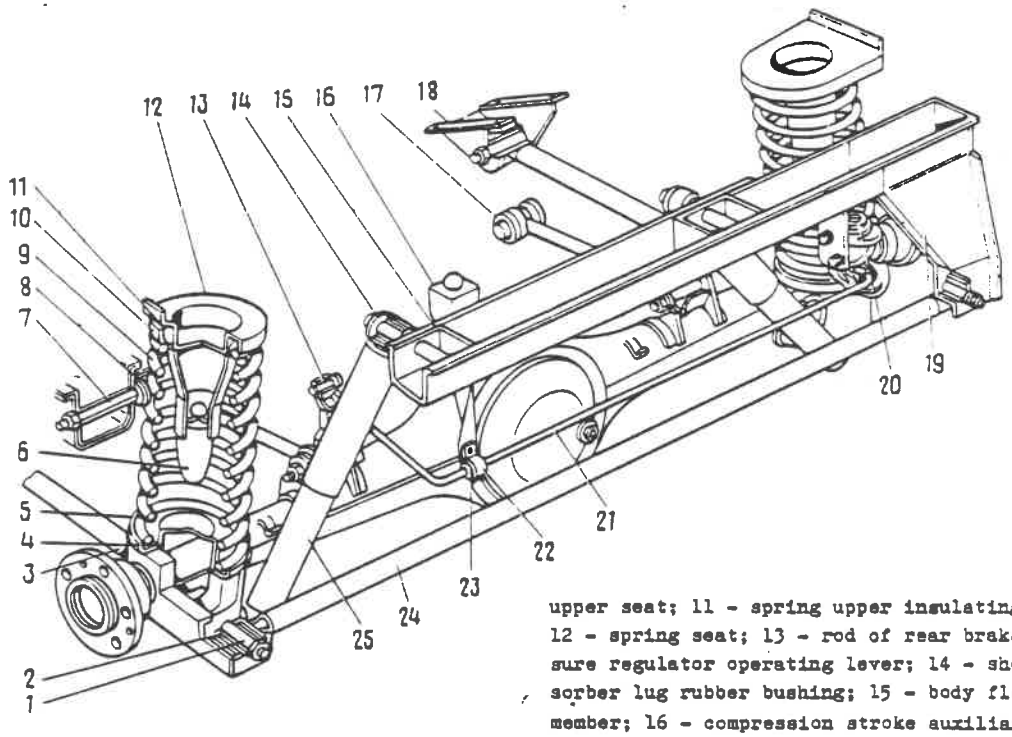


Fig.4-14. Rear Suspension:
1 - spacer bushing; 2 - rubber bushing; 3 - lower longitudinal radius rod; 4 - spring lower insulating gasket; 5 - spring lower seat; 6 - compression stroke buffer; 7 - upper longitudinal radius rod bolt; 8 - upper longitudinal radius rod bracket; 9 - suspension spring; 10 - spring upper seat; 11 - spring upper insulating gasket; 12 - spring seat; 13 - rod of rear brake pressure regulator operating lever; 14 - shock absorber lug rubber bushing; 15 - body floor cross-member; 16 - compression stroke auxiliary buffer; 17 - upper longitudinal radius rod; 18 - lower longitudinal radius rod bracket; 19 - transverse radius rod-to-body bracket; 20 - brake pressure regulator; 21 - pressure regulator operating lever; 22 - lever supporting bushing holder; 23 - lever supporting bushing; 24 - transverse radius rod; 25 - shock absorber

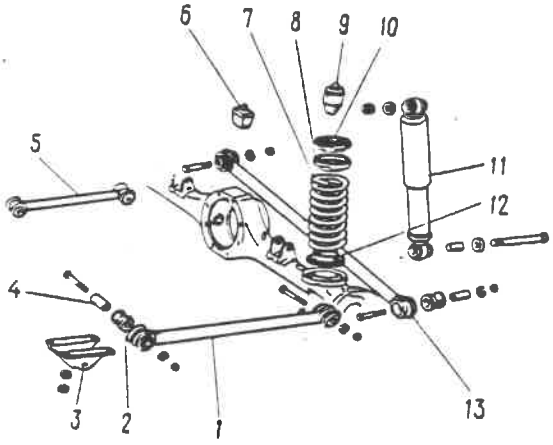


Fig.4-15. Rear Suspension Parts:
1 - lower longitudinal radius rod; 2 - rubber bushing; 3 - bracket; 4 - spacer bushing; 5 - upper longitudinal radius rod; 6 - compression stroke auxiliary buffer; 7 - spring; 8 - spring upper seat; 9 - compression stroke buffer; 10 - spring upper insulating gasket; 11 - shock absorber; 12 - spring lower insulating gasket; 13 - transverse radius rod

Inspection

Before inspection, take care to wash all the parts thoroughly.

Protect the rubber parts, bushings and protective coatings against contact with solvents in the course of washing.

Springs. Check the resilience of the spring by the reference points (Fig.4-17), first compressing it until the coils close.

Note. According to their length under a load of 3425 N (350 kgf), the springs are divided into two classes: class A (longer than 278 mm) and class B (278 mm or shorter).
The springs of class A are unmarked, while those of class B are marked black on the external side of the coils.

Check the springs for deformation. Replace the spring if its resilience is other than indicated in Fig.4-17 or its deformation may violate its efficient operation.

Examine the supporting rubber gaskets of the springs and replace them by new ones, if necessary.

Radius rods. Check the following:

- distortion of the rods; straighten them, if possible;
- look for cracks on the brackets of the rear axle beam and car body; repair the brackets, if they are cracked;
- examine the flexible bushings of the radius rod joints; replace them by new ones, if necessary, using the set of tools 67.7820.9517.

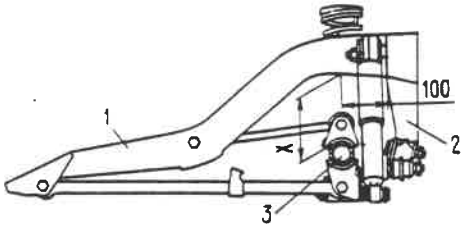


Fig.4-16. Rear Suspension Installation Diagram: 1 - body side member; 2 - transverse radius rod bracket; 3 - rear axle beam; X = 152 mm

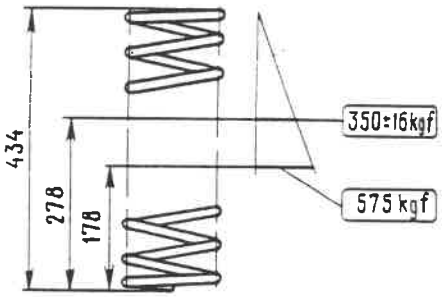


Fig.4-17. Main Data for Checking Rear Suspension Spring

SHOCK ABSORBERS

The design of the front and rear suspension shock absorbers is shown in Fig.4-18.

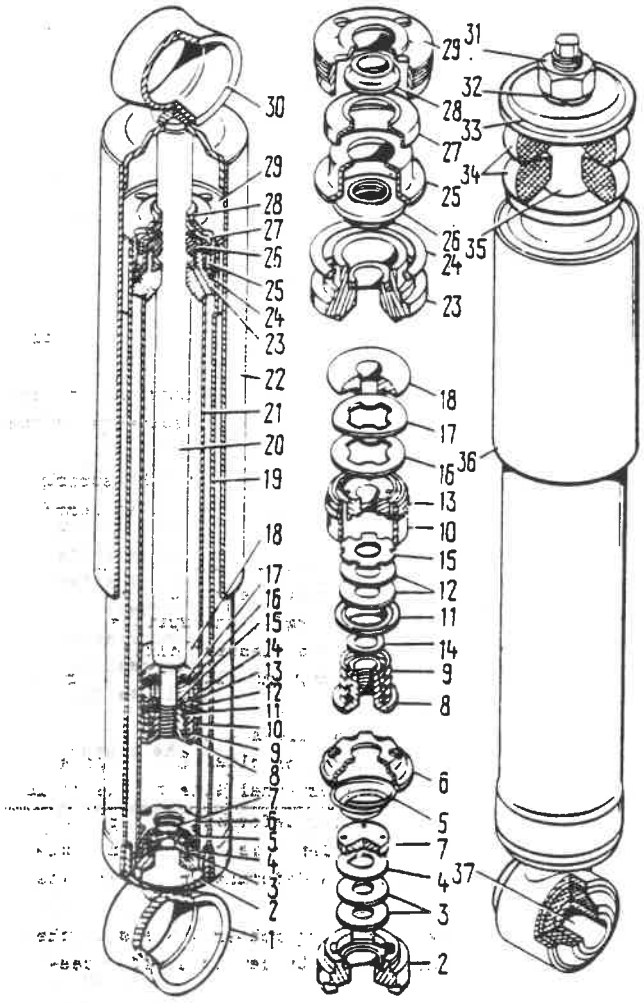


Fig.4-18. Front and Rear Suspension Shock Absorbers: 1 - lower lug; 2 - compression valve body; 3 - compression valve discs; 4 - compression valve throttling disc; 5 - compression valve spring; 6 - compression valve holder; 7 - compression valve plate; 8 - rebound valve nut; 9 - rebound valve spring; 10 - shock absorber piston; 11 - rebound valve plate; 12 - rebound valve discs; 13 - piston ring; 14 - rebound valve nut washer; 15 - rebound valve throttling disc; 16 - bypass valve plate; 17 - bypass valve spring; 18 - limiting plate; 19 - reservoir; 20 - rod; 21 - cylinder; 22 - dust shield; 23 - rod guide bushing; 24 - reservoir sealing ring; 25 - gland holder; 26 - rod gland; 27 - rod protective ring gasket; 28 - rod protective ring; 29 - reservoir nut; 30 - shock absorber upper lug; 31 - front suspension shock absorber upper fastening nut; 32 - spring washer; 33 - shock absorber pad washer; 34 - pad; 35 - spacer bushing; 36 - shock absorber dust shield; 37 - silent block

Stand Checks

To assess the serviceability of a shock absorber, check its performance curve in a dynamometer test stand.

Take the performance curves in accordance with the stand operating instructions after at least five working cycles at a fluid temperature of (20±5) °C, a flywheel speed of 60 min^{-1} and a rod travel of 80 mm for the front shock absorber and 100 mm for the rear one.

The curve on the diagram (Fig.4-19) should be fair; at the transition points between the rebound and compression strokes there should be no sections parallel to the zero line.

Fig.4-19. Shock Absorber Performance Curve: I - rebound stroke force; II - compression stroke force

Evaluation of performance curves. The resistance during the rebound and compression strokes is determined by the maximum ordinates of the corresponding curves.

The peak of the rebound stroke curve on a scale of 47 N (4.8 kgf) per 1 mm should lie at the following distances (A) from the zero line: 25 - 32 mm for the front shock absorbers and 23.5 - 30.5 m for the rear ones.

The peak of the compression stroke curve on the same scale should lie at the following distances (B) from the zero line: 3.5 - 6.5 mm for the front shock absorbers and 4.5 - 7.5 mm for the rear ones.

The reference values of the ordinates on the curves for the front and rear shock absorbers are given for cold shock absorbers at a fluid temperature of (20±5) °C.

After the check, remove the shock absorber from the stand and, if necessary, recondition or replace the faulty parts.

Repeat the check to make sure that the shock absorbers function as they should.

Disassembly and Assembly

Wash the shock absorber on the outside and clamp it in a vice.

Note. For clamping the shock absorber and its parts in a vice, use special soft jaws 67.7824.9513-001.

Pull the shock absorber rod all the way out, unscrew reservoir nut 29 (Fig.4-18) with wrench A.57034/R, take operating cylinder 21 with rod and compression valve out of the reservoir. Withdraw the reservoir from the vice and drain the fluid.

Using wrench 67.7824.9513-005, remove rod guide bushing 23 from the operating cylinder. Remove rod 20 with piston 10 from the cylinder and drain the fluid. Drive carefully compression valve body 2 with associated parts from the cylinder with a special mandrel.

Clamp the rod with the piston in a vice with special jaws and unscrew rebound valve nut 8. Remove piston 10 with bypass and rebound valves, rod guide bushing 23, rod gland 26, gland holder 25 and other parts.

Note. To facilitate inspection of the front suspension shock absorber rod which is covered by the dust shield, it is good practice to press off the dust shield.

Disassemble the compression valve. For this purpose remove holder 6, then take valve spring 5, plate 7 and discs 3 and 4 one after another out of body 2.

To assemble the shock absorber reverse the disassembly procedure, observing the following requirements:

- having assembled the compression valve, make sure there is free travel of plate 7 and valve discs;
- press-fit holder 6 on body 2 with a special mandrel;
- press-fit the compression valve into the cylinder with mandrel 67.7824.9513-004;
- to facilitate assembly of the rod-mounted parts use guide 67.7824.9513-003;
- throttling disc 15 of the front shock absorber has two slots on the outside diameter, while that of the rear shock absorber, three slots;
- tighten the rebound valve nut with a torque of 11.76 - 15.68 N.m (1.2 - 1.6 kgf.m);
- tighten the reservoir nut with wrench 67.7824.9513-002 with a torque of 68.6 - 88.2 N.m (7 - 9 kgf.m).

Inspection of Parts

Wash all metal parts and leave them to dry; wash rubber parts with lukewarm water and wipe them with clean cloth.

Check thoroughly to see that the parts meet the following requirements:

- the discs of the compression and rebound valves and the plate of the bypass valve should not be distorted; the plate of the bypass valve should be flat within 0.05 mm;
- the working surfaces of the piston, piston ring, rod guide bushing, cylinder and valve parts should be free of scores and nicks that may affect the normal functioning of the shock absorber;
- the springs of the rebound and compression valves should be intact and sufficiently resilient;
- the compression valve discs should be intact and not seriously worn;
- it is good practice to replace the gland by a new one during repairs.

Replace all defective parts and proceed with assembling the shock absorber.

Section V

STEERING GEAR

The design of the steering gear is shown in Figs 5-1, 5-2.

The roller of the pitman arm shaft can be installed either on a needle bearing or a ball bearing. The figures in the text are given for both versions, the asterisk (*) referring to the version with the needle bearing.

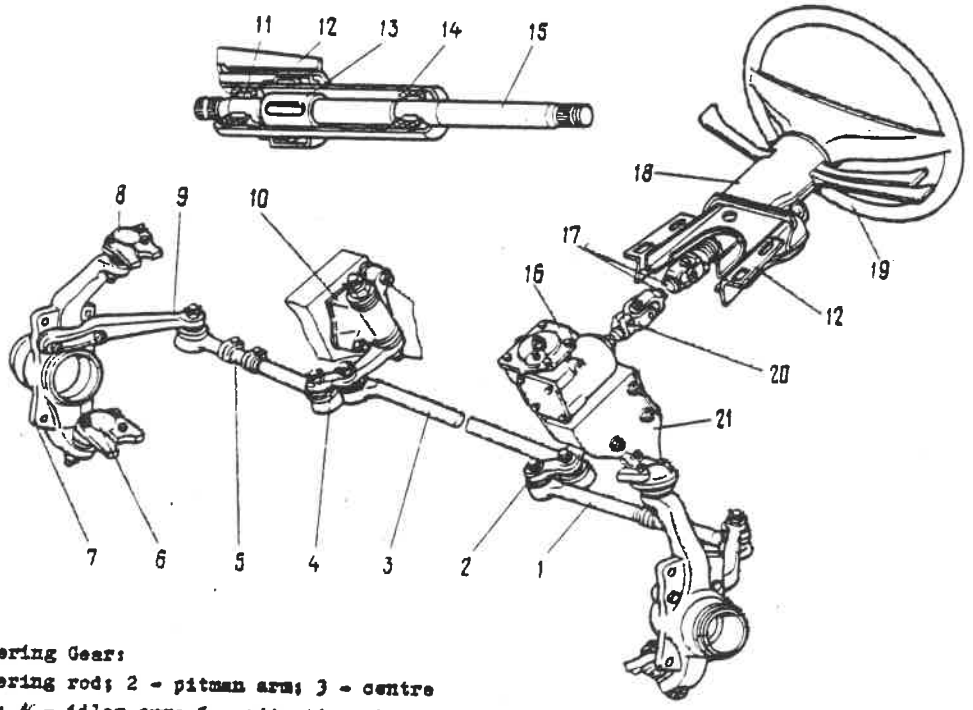


Fig.5-1. Steering Gear:
1 - side steering rod; 2 - pitman arm; 3 - centre steering rod; 4 - idler arm; 5 - adjusting sleeve; 6 - suspension lower ball joint; 7 - R.H. steering knuckle; 8 - suspension upper ball joint; 9 - R.H. knuckle arm; 10 - idler arm bracket; 11 - upper shaft bearing; 12 - steering shaft bracket; 13 - lock bushing; 14 - steering shaft bracket pipe; 15 - upper steering shaft; 16 - steering gear case; 17 - intermediate steering shaft; 18 - steering shaft casing; 19 - steering wheel; 20 - universal joint tie-bolt; 21 - body side member

TROUBLE SHOOTING

Cause	Remedy
Excessive Steering Wheel Play	
1. Loosening of steering gear case bolts	1. Draw up nuts
2. Loosening of steering rod ball pin nuts	2. Examine and tighten nuts
3. Excessive play in steering rod ball joints	3. Replace steering rods or their heads
4. Excessive clearance in front wheel hub bearings	4. Adjust clearance
5. Excessive roller-to-worm backlash	5. Adjust backlash
6. Excessive clearance between idler arm shaft and bushings	6. Replace bushings or bracket assembly

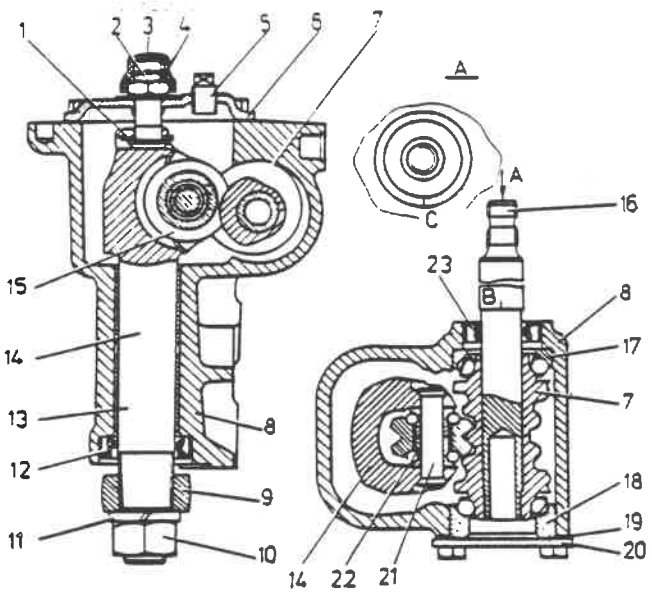


Fig.5-2. Steering Mechanism Cross Section:
1 - adjusting screw plate; 2 - pitman arm shaft adjusting screw; 3 - cap; 4 - adjusting screw nut; 5 - oil filler plug; 6 - cover; 7 - worm; 8 - steering gear case; 9 - pitman arm; 10 - pitman arm-to-shaft nut; 11 - spring washer; 12 - gland; 13 - bronze bushing; 14 - pitman arm shaft; 15 - pitman arm shaft roller; 16 - worm shaft; 17 - upper ball bearing; 18 - lower ball bearing; 19 - adjusting shims; 20 - worm bearing lower cover; 21 - roller shaft; 22 - ball bearing; 23 - worm shaft gland; B,C - marks

Continued

Cause	Remedy
7. Excessive clearance in worm bearings	7. Adjust clearance
8. Loosening of bolts which fasten steering intermediate shaft to worm shaft or to upper steering shaft	8. Tighten bolts

Difficult Rotation of Steering Wheel

1. Deformation of steering linkage parts	1. Replace distorted parts
2. Wrong front wheel alignment angles	2. Check and adjust wheel alignment
3. Wrong roller-to-worm backlash	3. Adjust backlash
4. Overtightening of idler arm shaft adjusting nut	4. Adjust tightening of nut
5. Underinflation of front wheel tyres	5. Inflate to normal pressure
6. Ball joint parts damaged	6. Examine and replace faulty parts
7. No oil in steering gear case	7. Check and top up. Replace gland, if necessary
8. Damaged bearings of upper steering shaft	8. Replace bearings

Knocking in Steering Gear

1. Excessive clearance in front wheel hub bearings	1. Adjust clearance
2. Loosening of steering rod ball pin nuts	2. Check and tighten nuts

Continued

Cause	Remedy
3. Excessive clearance between idler arm shaft and bushings	3. Replace bushings or bracket assembly
4. Loosening of idler arm shaft adjusting nut	4. Adjust tightening of nut
5. Wrong roller-to-worm backlash or clearance in worm bearings	5. Adjust backlash or clearance
6. Excessive clearance in steering rod ball joints	6. Replace steering rods or their heads
7. Loose fastening bolts of steering gear case or idler arm bracket	7. Check and tighten bolt nuts
8. Loosening of knuckle arm nuts	8. Tighten nuts
9. Loose bolts of steering shaft	9. Tighten bolt nuts

Front Wheel Shimmy

1. Wrong tyre pressure	1. Check and adjust tyre pressure
2. Wrong front wheel alignment angles	2. Check and adjust alignment angles
3. Excessive clearance in front wheel hub bearings	3. Adjust clearance
4. Wheels out of balance	4. Balance wheels
5. Loosening of steering rod ball pin nuts	5. Check and tighten nuts
6. Loose bolts of steering gear case or idler arm bracket	6. Check and tighten bolt nuts
7. Wrong roller-to-worm backlash	7. Adjust backlash

Continued

Cause	Remedy
Car Pulls Aside	
1. Non-uniform tyre pressure	1. Check and adjust tyre pressure
2. Wrong front wheel alignment angles	2. Check and adjust alignment angles
3. Different sagging of front suspension springs	3. Replace faulty springs
4. Distorted steering knuckles or wishbones	4. Examine knuckles and wishbones and replace faulty parts
5. Incomplete release of one or more wheel brakes	5. Inspect brake system
Poor Road Stability	
1. Wrong front wheel alignment angles	1. Check and adjust alignment angles
2. Excessive clearance in front wheel bearings	2. Adjust clearance

Continued

Cause	Remedy
3. Loosening of steering rod ball pin nuts	3. Check and adjust nuts
4. Excessive clearance in steering rod ball joints	4. Replace steering rods or their heads
5. Loose bolts of steering gear case or idler arm bracket	5. Check and tighten bolt nuts
6. Excessive roller-to-worm backlash	6. Adjust backlash
7. Distortion of steering knuckles or wishbones	7. Check steering knuckles and wishbones; replace distorted parts
Oil Leaks from Steering Gear Case	
1. Gland of pitman arm shaft or of worm worn out	1. Replace gland
2. Loose bolts of steering gear case covers	2. Tighten bolts
3. Gaskets damaged	3. Replace gaskets

INSPECTION, CHECKS AND ADJUSTMENT

General Inspection

If the steering gear becomes in any way defective (knocking, excessive play or, on the contrary, difficult rotation of the steering wheel, etc.), examine the parts on a trestle or inspection pit in the following order.

Clean the steering linkage and gear case of dirt. Set the wheels in the straight-ahead position.

Turning the steering wheel back and forth, make sure that:

- the steering wheel play is not over 5° (or 18-20 mm as measured on the wheel rim); make this check with gauging mandrel 67.8720.9501;
- there is no knocking in the steering linkage joints and in the steering mechanism;
- the steering gear case and idler arm bracket are reliably fastened (tighten the screw joints, if necessary);
- there is no play in the steering rod ball joints and in the idler arm bracket and no end play of the worm shaft;
- the turning force applied to the steering wheel (with the front wheels resting on a smooth plate) is not over 196 N (20 kgf), 245 N*(25 kgf)*.

Turning the adjusting sleeves of the side rods, make sure that their clamps are securely tightened.

Examine the ball joints and rubber boots as described below.

Checking Steering Rod Ball Joints

The first thing is to check the travel of the rod heads along the pin axis. For this purpose, the head should be moved in parallel to the pin axis with the aid of a lever and a support.

Axial travel of the rod head relative to the pin should be from 1 to 1.5 mm. This amount of travel indicates that the pin seat is not jammed in the rod head socket and can move together with the pin, compressing the spring. If the seat is jammed, replace the entire ball joint.

Turning the steering wheel back and forth, hand-feel the steering rod joints for play. If the ball joint is felt to be loose, replace the steering rod as a whole, or its head alone.

Examine the boots of the steering rod ball joints.

If the boots are intact and ensure adequate cleanliness inside the joints, the service life of the latter is practically unlimited. Moisture, dust, etc., getting into the joint cause premature wear of its parts.

The boot should be replaced if it is cracked, fractured or when the lubricant oozes outside on squeezing the boot with fingers.

Checks and Adjustment of Steering Worm Bearings

Set the front wheels in the straight-ahead position and, moving the steering wheel back and forth, check to see that the distance between the face of steering gear case 8 (Fig.5-2) and mark "B" on the steering worm shaft does not change.

If it does, this is an evidence of play in the worm bearings.

To adjust the clearance in the worm bearings, turn the steering wheel 1 - 1.5 of a revolution to the left, unscrew the bolts of lower cover 20 and drain oil from the steering gear case. Remove the lower cover, take out one of shims 19 or replace it by a thinner one.

Note. The spare shims are available in the thickness of 0.10 and 0.15 mm.

Secure the lower cover and check again for axial play of the worm in its bearings. If there is no play, fill the steering gear case with 0.215 l of ТАД-17И transmission oil.

Check the force required for turning the steering wheel, placing the front wheels on a smooth metal plate. The force should not exceed 196 N (20 kgf), 245 N (25 kgf).

Checks and Adjustment of Roller-to-Worm Mesh

Having ascertained that there is no end play of the worm in the bearings, press out the ball joint pins with remover A.47035 from the holes in the pitman arm and disconnect the steering rods from the latter, keeping the front wheels in the straight-ahead position.

Rocking the pitman arm by its head, check for backlash in the roller-to-worm mesh. There should be no perceptible free travel of the pitman arm, with the steering wheel turned through 30° from the neutral position in either direction.

If, however, free travel of the pitman arm is noticed, remove cap 3 (Fig.5-2), loosen nut 4 of the adjusting screw and raising a little washer turn in adjusting screw 2 until the clearance is taken up. Do not overtighten the adjusting screw. Then, holding the adjusting screw with a screwdriver, tighten nut 4.

Once you are sure that the pitman arm has no free travel, connect the ball joint pins to it. Check the force required for turning the steering wheel. If it exceeds 196 N (20 kgf), loosen adjusting screw 2 and put on cap 3.

STEERING MECHANISM

Removal and Installation

Removal. Disconnect the wires from the storage battery and remove the horn switch face cover.

Turn off the steering wheel attachment nut and remove the steering wheel. Take off both halves of the steering shaft casing.

Note. If the steering gear case alone is to be removed, unscrew the bolt which fastens the yoke of the lower universal joint of the intermediate steering shaft on the worm shaft and the case-to-side member bolts.

Remove the instrument panel and disconnect the connector plugs of the three-lever switch from their mating sockets of the wire harness.

Disconnect the wires from the ignition switch terminals; screw out the fastening screws and, forcing in the lock retainer, remove the ignition switch. Loosen the clamp of the direction indicator, headlight and windshield wiper switch body and remove the latter.

Unscrew the bolt which holds the yoke of the lower universal joint of the intermediate shaft to the steering worm shaft.

Unscrew the bolts of bracket 6 (Fig.5-3) and take off the steering shaft complete with the bracket.

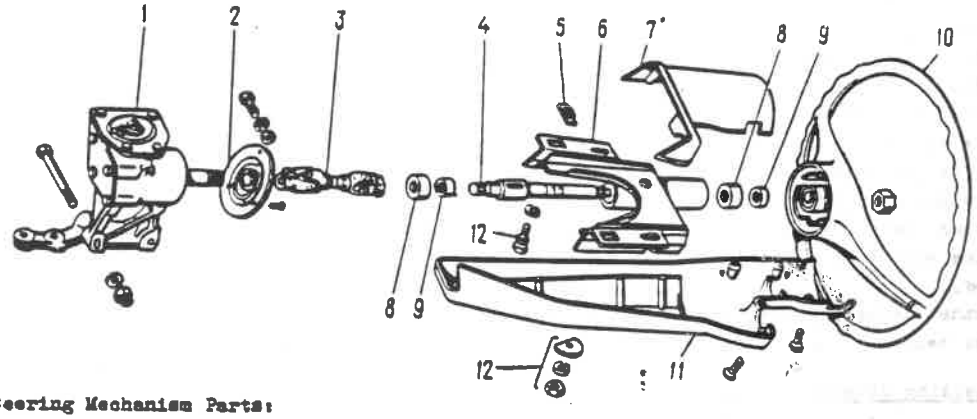


Fig.5-3. Steering Mechanism Parts:
1 - steering gear case; 2 - shaft seal; 3 - intermediate shaft; 4 - upper shaft; 5 - bracket front part fixing plate; 6 - bracket; 7 - casing upper part; 8 - bearing bushing; 9 - needle bearing; 10 - steering wheel; 11 - casing lower part; 12 - steering gear shaft bracket attachment parts

Unscrew the nuts which fasten the ball pins of the side and central steering rods to the pitman arm and then, using remover A.47035, drive the ball pins out of their holes in the pitman arm.

Take off the steering gear case, first unscrewing the bolts fastening it to the body side member. Take the seal of the steering shaft out of the hole in the dash panel.

Installation. Fit seal 2 (Fig.5-3) in the hole of the dash panel having aligned the projections of the seal with the slot in the hole of the dash panel, install the steering gear case on the body side member, without screwing home the nuts of the case bolts.

Using a special device, position the gear case so that angle α (Fig.5-4) is not over 32°, and the clearance between the shaft and the brake pedal is not under 5 mm. Then tighten home the nuts of the steering gear case bolts.

Set the pitman arm in the middle position by aligning the marks on the gear case and on the worm shaft (Fig.5-2).

Put the steering wheel temporarily on the shaft with the wheel arms horizontal and, in this position, connect the universal joint yoke of the intermediate steering shaft to the worm shaft, taking care to make tie-bolts pass through the circular groove of the worm. Then fasten the steering shaft bracket to the car body.

Remove the steering wheel and put the direction indicator, headlight and windshield wiper switch on the steering shaft.

Put the steering wheel on the shaft so that its arms are horizontal.

Check the steering wheel for smooth and easy rotation in both directions, then tighten its nut and lock-punch it at three points. Shift the body of the direction indicator, headlight and windshield wiper switch all the way towards the steering wheel and tighten the switch clamp.

Connect the wires to the ignition switch terminals and secure the switch with screws on the steering shaft bracket.

Connect the plugs of the direction indicator, headlight and windshield wiper switch to the wire harness sockets.

Put two halves of the shaft casing on the shaft and fasten them together with screws. Coat the surface of the lower contact ring of the steering wheel with a thin layer of grease and install the face cover of the horn switch on the steering wheel.

Install the ball pins of the centre and L.H. side steering rods on the pitman arm and secure them with nuts.

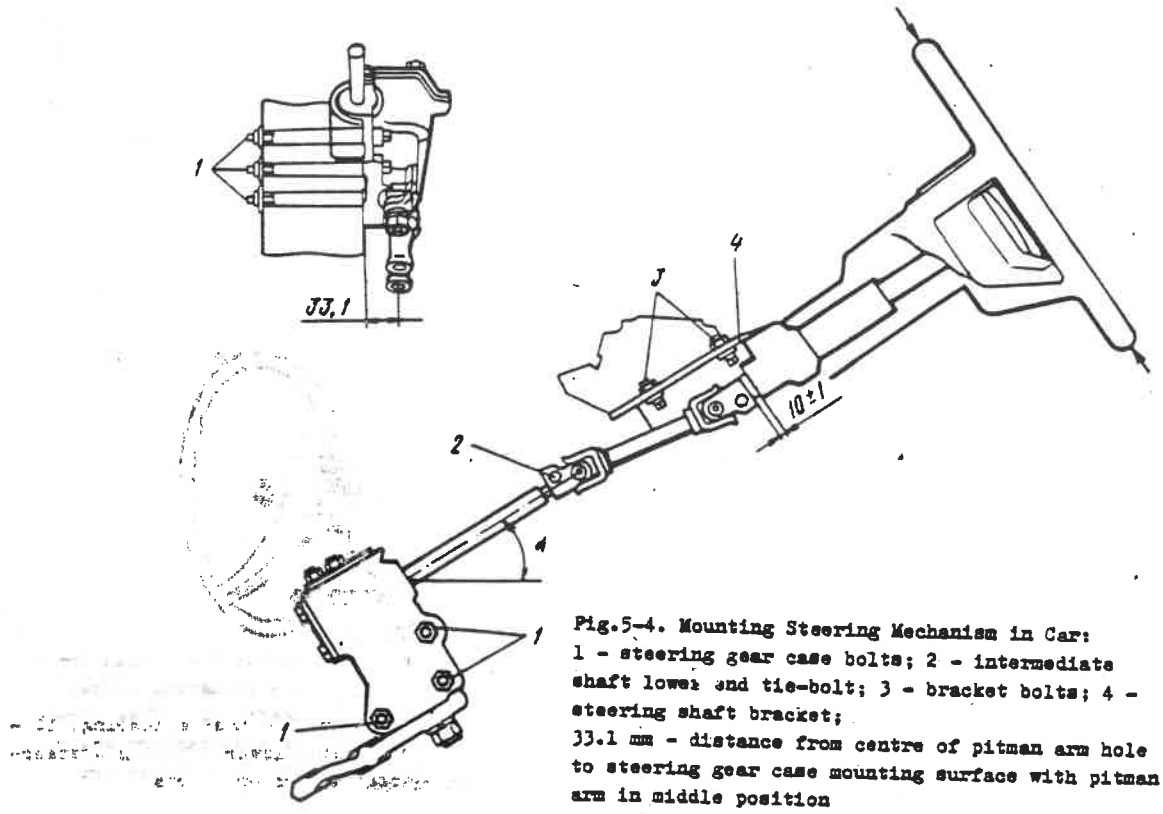


Fig.5-4. Mounting Steering Mechanism in Car:
1 - steering gear case bolts; 2 - intermediate shaft lower end tie-bolt; 3 - bracket bolts; 4 - steering shaft bracket;
33.1 mm - distance from centre of pitman arm hole to steering gear case mounting surface with pitman arm in middle position

Adjust the toe-in of the front wheels and check the force required for turning the steering wheel. With the front wheels placed on a smooth plate, this force should not be over 196 N (20 kgf) 245 N*(25 kgf)*, measured on the wheel rim.

Note. As an alternative, the steering shaft can be assembled separately with the direction indicator, headlight and windshield wiper switch and the steering wheel; then the assembled unit as a whole can be installed in the car.

To secure this unit, set the steering wheel arms horizontally and connect the worm shaft with the lower end of the steering intermediate shaft taking care to make tie-bolts pass through the circular groove of the worm.

Screw in the bracket bolts preliminarily, turn the steering wheel a few times back and forth and tighten home the bracket bolts.

Disassembly and Assembly of Steering Gear Case

Disassembly. Drain oil from the steering gear case. Fasten the case on bracket A.74076/R with support A.74076/1.

Unscrew the nut of pitman arm 2 (Fig.5-5), take off the spring washer and, using remover A.47043, remove the pitman arm (Fig.5-6). Turn off the fastening bolts, remove cover 12 (Fig.5-5) of the steering gear case complete with the cap, adjusting screw 8, adjusting plate 9, lock washer 10 and the locknut. Take pitman arm shaft 7 complete with the roller out of steering gear case 1.

Turn out the fastening bolts, remove cover 3 of the worm shaft thrust bearing complete with shims 4.

Push bearing outer race 5 by worm shaft 11 out of the case and pull out the shaft complete with bearing cage 6. Remove glands 15 and 16 of the worm shaft and pitman arm shaft, respectively.

Using mandrel 67.7853.9541, take out the outer race of the upper bearing (Fig.5-7).

Assembly. Assemble the steering mechanism on bracket A.74076/R by reversing the disassembly operations.

Press on the outer race of the worm upper bearing with mandrel 67.7853.9541, having fitted the attachment on the mandrel handle with the other side.

Having installed the worm into the steering gear case and fastened the lower cover (Fig.5-8), check friction torque of the worm shaft using dynamometer C2.7812.9501 and head A.95697/5 (Fig. 5-9); the friction torque should range from 1.9 to

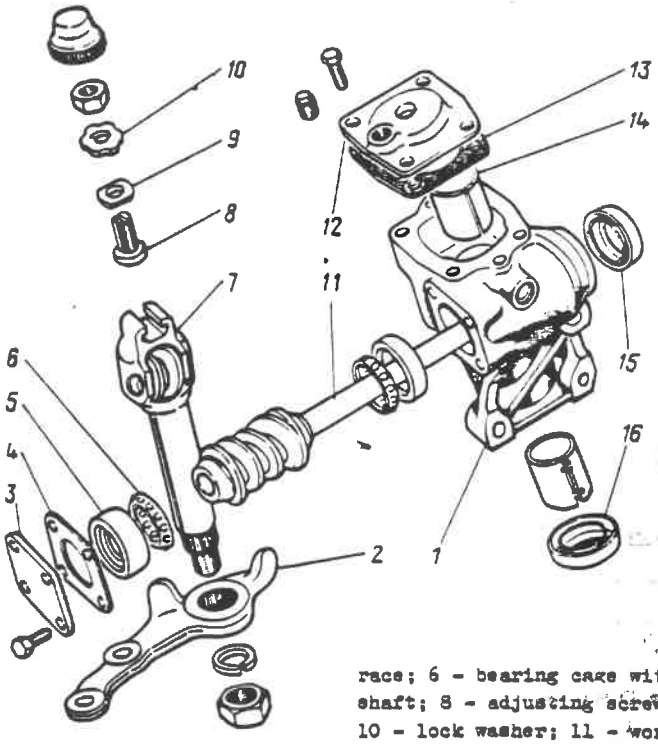


Fig.5-5. Steering Mechanism Parts:
1 - case; 2 - pitman arm; 3 - case lower cover; 4 - adjusting shims; 5 - worm shaft bearing outer race; 6 - bearing cage with balls; 7 - pitman arm shaft; 8 - adjusting screw; 9 - adjusting plate; 10 - lock washer; 11 - worm shaft; 12 - case upper cover; 13 - sealing gasket; 14 - pitman arm shaft bushing; 15 - worm shaft gland; 16 - pitman arm shaft gland

to 49 N.cm(2 - 5 kgf.cm). If the torque is lower or higher, reduce or increase the thickness of shims 2 (Fig.5-8), respectively.

After installation of the pitman arm shaft, check for absence of backlash in the roller-to-worm mesh with the worm shaft turned through 30° to the right and to the left from the neutral position of the pitman arm. Eliminate possible backlash by means of adjusting screw 2 (Fig.5-2) and tighten nut 4.

After adjustment of the roller-to-worm mesh, check the friction torque of the worm shaft with a dynamometer; on turning the worm shaft through 30° to the left and to the right from the middle position, it should be 68.7 - 88.3 N.cm (7-9 kgf.cm) and should diminish smoothly to 49 N.cm (5 kgf.cm) when the shaft is turned from the 30° position all the way to the stop.

On completion of assembly, check the pitman arm turning angles from the neutral position until the pitman arm comes to bear against the bolt heads; these angles should be 32°10' ±1° both to the right and to the left. Then fill the steering gear case with 0.215 l of transmission oil ТАД-17И.

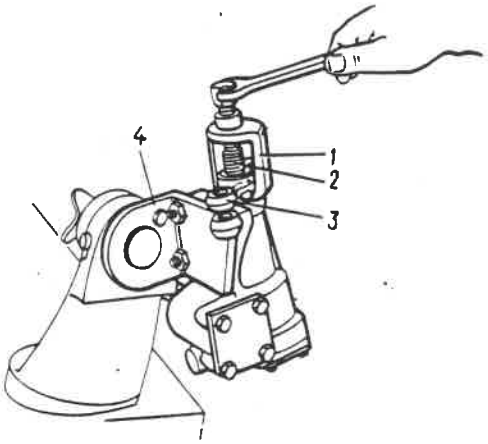


Fig.5-6. Removing Pitman Arm:
1 - remover A.47043; 2 - pitman arm shaft; 3 - pitman arm; 4 - bracket A.74076/R

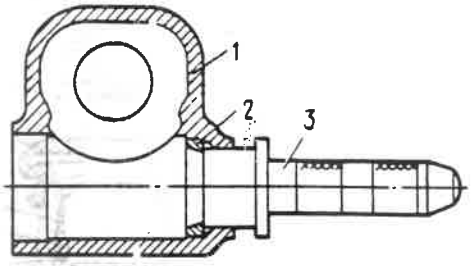


Fig.5-7. Removing Worm Upper Bearing Outer Race with Mandrel 67.7853.9541:
1 - steering gear case; 2 - worm upper bearing outer race; 3 - mandrel 67.7853.9541

Checks and Repairs

Examine the roller and worm carefully for wear, notches or signs of jamming on the working surfaces. Replace any worn and damaged parts.

Measure the clearance between the pitman arm shaft and bushings; it should not be over 0.10 mm; if it is larger, replace the bushings with the aid of driver A.74105.

The internal surface of the pitman arm shaft bushings has spiral grooves which open on one side of the bushings only. While pressing in the bushings, arrange them so that their faces with groove outlets are inside the hole in the case, and the outlets are located opposite each other. The bushing faces should sink 1.5 mm into the hole of the steering gear case.

Before press-fitting the new bushings, coat them with transmission oil.

The bushings pressed into the case should be finally machined with reamer A.90336 to a diameter of 28.698 - 28.720 mm. The assembly clearance between the pitman arm shaft and bushings should be from 0.008 to 0.051 mm.

Check the pitman arm shaft roller for ease of rotation on the ball bearing.

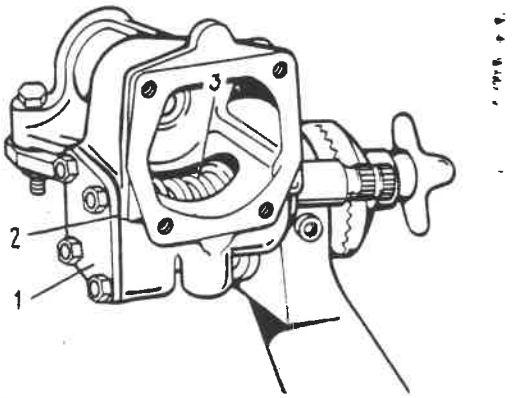


Fig.5-8. Installing Steering Worm:
1 - bearing cover; 2 - adjusting shim; 3 - worm

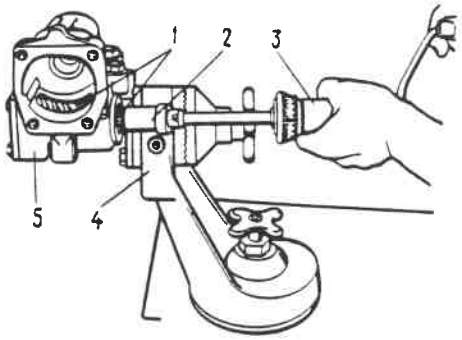


Fig.5-9. Worm Friction Torque Dynamometer Check:
1 - worm; 2 - head A.95697/5; 3 - dynamometer 02.7812.9501; 4 - repair stand bracket; 5 - steering gear case

The ball bearings of the steering worm and roller should rotate freely, without binding; the surfaces of the races and balls must bear no signs of wear and damage.

Check the axial clearance between the head of adjusting screw 8 (Fig.5-5) and the slot of pitman arm shaft 7. This clearance should not be over 0.05 mm. If it is larger, replace adjusting plate 9 by a thicker one.

Note. The spare adjusting plates are available in eleven sizes, varying in thickness from 1.95 mm to 2.20 mm in 0.025 mm steps.

Examine fixing plates 5 (Fig.5-3) and replace them, if distorted.

Disassembly and Assembly of Steering Shaft

Disassembly. Unscrew the tie bolt of the universal joint yoke and disconnect the intermediate and upper steering shafts.

If the upper shaft or its bearings are damaged, unstake the bracket pipe and take shaft 15 (Fig.5-1) complete with bearings 11 out of the pipe.

If the shaft turns in the bearings without binding and there is no free radial play in the bearings (elastic radial displacements of the steering shaft are tolerable), do not disassemble the upper steering shaft.

If the shaft or its bearings are worn or damaged, replace them by new ones.

For reassembly, reverse the disassembly operations, taking care to make the stop bolt of the universal joint pass through the circular groove of the upper shaft. Then stop-punch the bracket pipe in two points at both sides to fix the shaft bearings.

STEERING RODS AND BALL JOINTS

Removal and Installation

Uncotter and unscrew the nuts which fasten the ball pins of the side steering rods to the knuckle arms.

Remove the ball pins from the tapered sockets on the arms with remover 67.7824.9516 (Fig.5-10).

Uncotter and unscrew the nuts which fasten the ball pins of the centre and side steering rods to the pitman arm and idler arm. Using remover 67.7824.9516, take the ball pins from the arm sockets and remove the rods.

To install the steering rods, reverse the removal operations. All the nuts of the ball pins must be tightened with a torque-indicating wrench and cottered. If the slot of the nut does not coincide with the hole for the cotter pin, turn on the nut through an angle smaller than 60° to permit cottering.

After installation, adjust the toe-in of the front wheels.

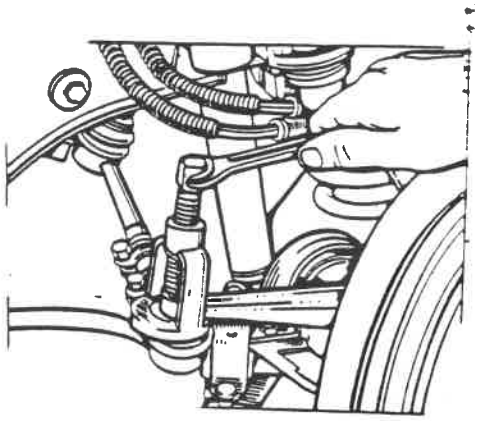


Fig.5-10. Removing Steering Rod Ball Pins

Checks and Repairs

Examine rubber boots 2 (Fig.5-11) as described above (see "Inspection, Checks and Adjustments"). Replace any damaged boots.

Measure the radial and axial clearance to assess the condition of the steering rod ball joints. If play of pin 1 in body 3 is felt, also when dirt or sand gets in or the ball pin is corroded or if all travel of the ball seat is completely used up, replace the joint complete with the rod head.

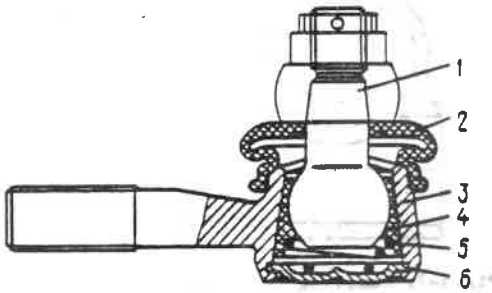


Fig.5-11. Steering Rod Ball Joint Cross Section: 1 - ball pin; 2 - boot; 3 - joint body; 4 - seat; 5 - spring; 6 - plug

Removal and Disassembly

Detach the idler arm from the ball pins of the centre and side steering rods, first uncottering and unscrewing the nuts and taking the ball pins from the arm sockets with remover 67.7824.9516. Then unscrew the bracket-to-side member bolts and remove the bracket.

Clamp the bracket in a vice, uncotter and unscrew nut 4 (Fig.5-12), remove washers 3 and 6 and idler arm 1 complete with shaft 9, washer 10 and self-locking nut 11; remove seals 7 and press out bushings 8.

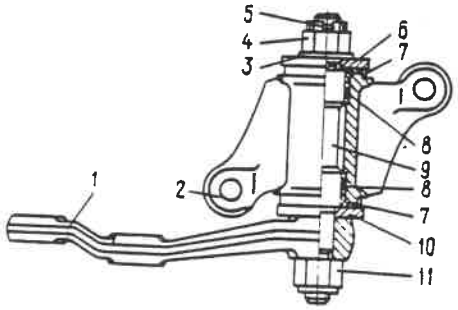


Fig.5-12. Idler Arm Bracket Cross Section:
1 - idler arm; 2 - bracket body; 3 - washer; 4 - adjusting nut; 5 - cotter pin; 6 - upper washer; 7 - seal; 8 - bushing; 9 - idler arm shaft; 10 - lower washer; 11 - self-locking nut

Checks

Examine the bushings of the idler arm shaft; if they are out-of-round or there is an excessive clearance between the shaft and the bushings, the latter must be replaced by new ones. Seals must be replaced simultaneously.

Examine the shaft for out-of-roundness and damage and replace it with a new one, if necessary. Make sure that the idler arm is not distorted; otherwise, replace it by a new one.

Assembly and Installation

Before assembly, coat the bushings of the idler arm shaft and fill the spaces between them with Литол-24 grease. Assemble the idler arm bracket by reversing the disassembly operations.

If shaft 9 has been replaced, tighten self-locking nut 11 of the arm with a torque-indicating wrench.

Washer 6 must be installed with the extrusions facing up.

After tightening nut 4, the idler arm positioned horizontally should not turn under its own weight. It must turn under a force of 9.8 - 19.6 N (1-2 kgf) applied to its end.

If nut 4 proves to be overtightened, unscrew it, lift washer 6 somewhat and tighten the nut again.

Secure the bracket on the side member by bolts with self-locking nuts and plain washers; tighten the nuts with a torque-indicating wrench.

Attach the steering rod ball pins to the idler arm.

Section VI

BRAKES

The layout of the brake system is shown in Fig. 6-1.

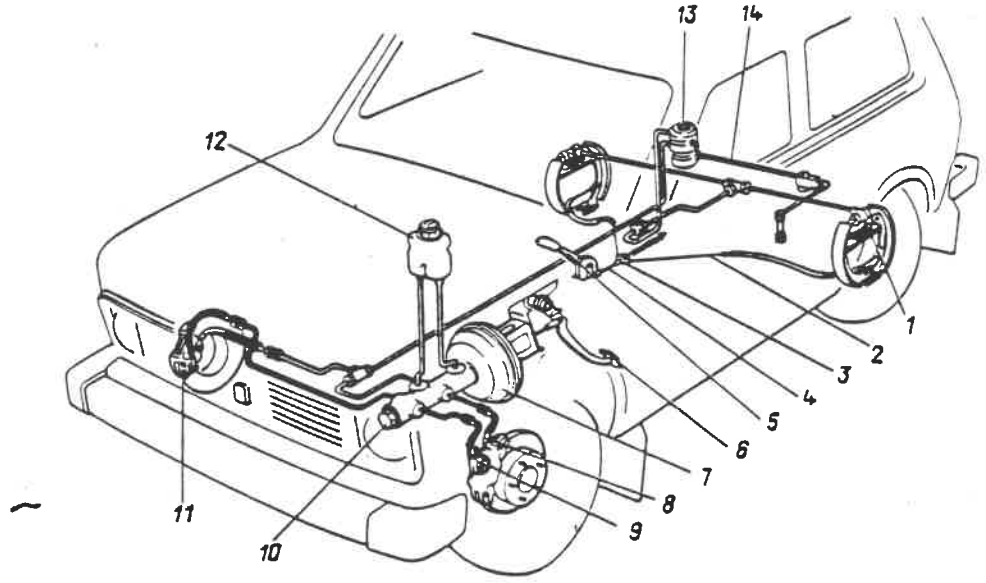


Fig.6-1. Brake System Diagram:
1 - rear brake wheel cylinder; 2 - parking brake rear cable; 3 - rear cable guide; 4 - parking brake front cable; 5 - parking brake lever; 6 - brake pedal; 7 - vacuum booster; 8 - secondary circuit pipe; 9 - primary circuit pipe; 10 - brake master cylinder; 11 - front brake cylinder block; 12 - brake fluid reservoir; 13 - pressure regulator; 14 - pressure regulator operating lever

TROUBLE SHOOTING

Cause	Remedy
Poor Braking Effect	
1. Fluid leaks from wheel cylinders of front or rear brakes	1. Replace faulty parts of wheel cylinders, wash and dry shoes and drums, bleed hydraulic system
2. Air in brake system	2. Bleed system
3. Damaged rubber seals of brake master cylinder	3. Replace seals and bleed system
4. Hydraulic rubber hoses damaged	4. Replace hoses
Spontaneous Braking with Engine Running	
Infiltration of air between valve body and boot	Replace vacuum booster

Continued

Cause	Remedy
Incomplete Release of All Wheel Brakes	
1. No free travel of brake pedal due to wrong position of stop light switch	1. Adjust position of switch
2. Protrusion of vacuum booster adjusting bolt from brake master cylinder mounting surface exceed $1.25_{-0.2}$ mm	2. Adjust position of adjusting bolt (See Fig. 6-2)
3. Jamming of vacuum booster valve body	3. Replace vacuum booster

Continued

Cause	Remedy
4. Clogging of master cylinder compensating hole	4. Clear out hole. Bleed hydraulic system
5. Swelling of master cylinder rubber seals caused by penetration of gasoline, mineral oils, etc. into fluid	5. Wash entire system thoroughly with brake fluid, replace faulty rubber parts, bleed hydraulic system
6. Jamming of brake master cylinder piston	6. Examine master cylinder, replace it, if necessary; bleed hydraulic system

One Wheel Drags with Pedal Released

1. Rear brake shoe return spring weak or broken	1. Replace spring
2. Jamming of wheel cylinder piston due to corrosion	2. Disassemble cylinder, clean and wash parts, replace faulty ones
3. Swelling of wheel cylinder sealing rings due to penetration of fuel or oil into fluid	3. Replace rings, wash brake system with fluid
4. No shoe-to-drum clearance	4. Adjust parking brake
5. Wrong position of brake caliper relative to brake disc due to loosening of shoe guide-to-steering knuckle bolts	5. Tighten bolts; if necessary, replace faulty parts
6. Excessive runout of brake disc (over 0.15 mm)	6. Grind disc. Replace if it is thinner than 9 mm

Car Skids or Pulls Sideways at Braking

1. Fluid leaks from one of wheel cylinders	1. Replace seals and bleed system
2. Jamming of wheel cylinder piston	2. Eliminate jamming, replace faulty parts, if necessary
3. Clogging of one of pipes due to denting or soiling	3. Replace or clean out pipe. Bleed system
4. Non-uniform tyre pressure	4. Adjust tyre pressure

Continued

Cause	Remedy
5. Wrong front wheel alignment angles	5. Adjust angles
6. Soiling or oiling of discs, drums and shoe linings	6. Clean brake parts
7. Wrong position of pressure regulator	7. Adjust its position
8. Pressure regulator faulty	8. Repair or replace it

Pedal Pressure Too Hard

1. Cloggong of air filter	1. Replace air filter
2. Vacuum booster valve body jamming	2. Replace vacuum booster
3. Hose between vacuum booster and engine intake manifold damaged or loosely fitted on pipe unions	3. Replace hose or tighten its clamps
4. Brake pedal metal bushings oxidized or run dry (drying of lubricant)	4. Replace worn parts or change lubricant

Brake Squeak or Squeal

1. Weakening of rear brake shoe return spring	1. Examine return spring and replace, if necessary
2. Rear brake drums out-of-round	2. Rebore drums
3. Shoe linings smeared with oil	3. Clean linings with wire brush, using warm water and detergents. Prevent penetration of fluid or oil to brake shoes
4. Shoe linings worn or fouled with embedded foreign particles	4. Replace shoes
5. Excessive runout or uneven wear of brake disc	5. Grind disc. Replace, if it is thinner than 9 mm

CHECK AND ADJUSTMENT

Checking Pipes and Joints.

To prevent sudden failure of the brake system, examine closely all pipes:

- the metal pipes should be free of dents or cracks and should be located sufficiently far from sharp edges which might cause their damage;

- the brake hoses should have no penetrating cracks on the external casing and should be out of contact with mineral oils and lubricants that are apt to eat away rubber; depress the brake pedal sharply and see that the hoses do not bulge; bulging is indicative of some defect;

- all the pipe clamps should be well tightened since their loosening will result in vibration leading to breakage;

- there should be no fluid leaks through the pipe joints; if necessary, tighten the unions home, taking care not to distort the pipes.

Replace the parts by new ones if there is even a slightest doubt as to their serviceability.

It is recommended that the flexible hoses, irrespective of their condition, be replaced by new ones after 100,000 kilometers of run or five years of service in order to preclude sudden bursting due to ageing.

After five years of operation, it is a good practice to change fluid.

Checking Vacuum Booster

With the engine shut down press the brake pedal 5 or 6 times, thus building up an equal pressure, close to atmospheric, in spaces A and B (Fig. 6-2). At the same time, see that valve body 21 is not jammed, judging by the force on the pedal.

Stopping the brake pedal midway of its travel, start the engine. If the booster is in order, the brake pedal will sink forward after engine starts.

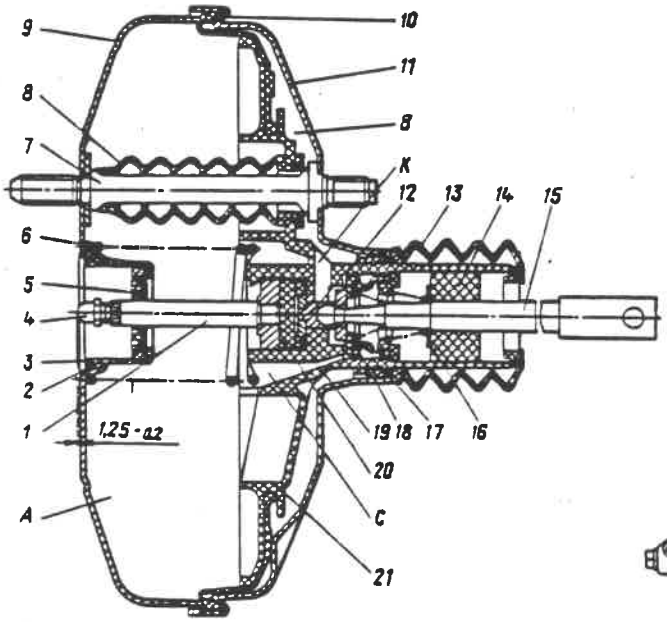


Fig.6-2. Vacuum Booster:
1 - rod; 2 - master cylinder flange sealing ring; 3 - booster casing cup; 4 - adjusting bolt; 5 - rod seal; 6 - diaphragm return spring; 7 - booster stud; 8 - sealing boot; 9 - booster casing; 10 - diaphragm; 11 - booster casing cover; 12 - piston; 13 - valve body boot; 14 - air filter; 15 - pushrod; 16 - pushrod return spring; 17 - valve spring; 18 - valve; 19 - valve body bushing; 20 - rod buffer; 21 - valve body; A - vacuum space; B - atmospheric pressure space; C,K - channels

If, however, the pedal fails to move forward, check the fastening of the hose nipple, condition and fastening of the nipple flange, fastening of the hose to the nipple and to the union of the engine intake manifold because a loosely fastened or damaged hose and flange decrease sharply the vacuum in space A and the efficiency of booster operation.

If the car gets braked spontaneously, check the vacuum booster for tightness with the engine running, first with the brake pedal released and then pressed on and held. Sticking of boot 13 to the extension of the valve body and the hissing sound of infiltrating air will indicate insufficient tightness of the booster. In this case the vacuum booster should be replaced.

Adjustment of Brake Operating Mechanism

Free travel of the brake pedal should be 3-5 mm with the engine shut down. This travel is ensured by moving stop light switch 7 (Fig. 6-3).

If the stop light switch is too close to the pedal, the latter fails to come back to the initial position; as a result, valve 18 (Fig. 6-2) bears against body 21 and disconnects spaces A and B which causes incomplete releasing of the wheel brakes when the pedal is released.

To adjust the position of the stop light switch, back off nut 8 (Fig. 6-3) and move the switch so that its buffer is in light contact with the brake pedal stop. In this position, free travel of the brake pedal should be within 3 to 5 mm. After adjustment do not fail to tighten nut 8.

Caution:

Free travel of the brake pedal should be adjusted with the engine shut down.

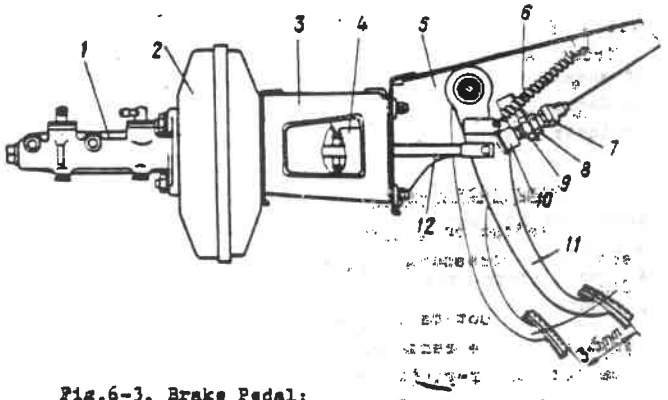


Fig.6-3. Brake Pedal:
1 - master cylinder; 2 - vacuum booster; 3 - vacuum booster bracket; 4 - seal cup; 5 - clutch and brake pedals bracket; 6 - brake pedal return spring; 7 - stop light switch; 8,9 - nuts; 10 - stop light switch buffer; 11 - brake pedal; 12 - pushrod

If it proves impossible to eliminate incomplete releasing of brakes by moving the stop light switch, disconnect the brake master cylinder from the vacuum booster and check the protrusion of adjusting bolt 4 (Fig. 6-2) relative to the mounting surface of the master cylinder flange ($1.25_{-0.2}$ mm). This distance can be set by holding the end of rod 1 with a special wrench and turning adjusting bolt 4 in or out with another wrench.

Adjustment of Parking Brake

If the parking brake fails to hold the car reliably on a 30 % gradient or is applied only after its lever has been shifted by more than 4-5 teeth of the ratchet mechanism, adjust the brake as follows:

- shift the parking brake lever in the extreme lower position and then raise it by two teeth of the quadrant;
- loosen locknut 5 (Fig. 6-4) and tension cable 1 by rotating adjusting nut 6;
- tighten locknut 5 and check to see whether the car remains braked when the lever is shifted by 4-5 teeth of the quadrant.

Note. If the cables have been replaced by new ones, apply the parking brake two-three times applying a force of about 400 N (40 kgf) to the parking brake lever. This will provide stretching of the cables.

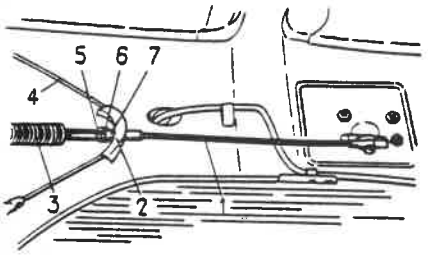


Fig. 6-4. Parking Brake Control Linkage:
1 - front cable; 2 - rear cable guide; 3 - front cable return spring; 4 - rear cable; 5 - locknut; 6 - adjusting nut; 7 - spacer bushing

Checking Serviceability of Pressure Regulator

Put the car on a lift or an inspection pit and clean the pressure regulator and its boot of dirt.

Take the boot carefully off the pressure regulator, remove remnants of lubricant and clean the torsion lever-piston joint.

Ask an assistant to press the brake pedal with a force of 686-784 N (70-80 kgf), watching at the same time for the protruding part of the pressure regulator piston.

If the piston moves through 0.5-0.9 mm relative to the regulator body thus twisting the torsion lever, it means that the pressure regulator is in order. Press the brake pedal again 2 or 3 times to make certain that the pressure regulator is fully serviceable.

If the piston stays still after depression of the brake pedal (this is caused by sticking of the corroded piston to the body), replace the regulator.

On ascertaining that the pressure regulator is fully serviceable and there are no fluid leaks between the pressure regulator piston and body, apply a thin layer of ЛТ-1 grease to the axle and to the protruding portion of the piston, pack 5-6 g of the same lubricant into the rubber boot and put the latter back in position.

Adjusting Position of Pressure Regulator

If the regulator fastening bolts became loose, adjust the regulator position first jacking up the rear axle of the car. Then disconnect lever 4 (Fig. 6-5) from link 7 and attach fixture 67.7820.9519 to the end of the lever. Direct the spindle of the fixture upward to bear against the car body floor (Fig. 6-6). This will set a distance "X" of (150 ± 5) mm between the end of the lever and the body side member (Fig. 6-5).

Lift rubber boot 5 (Fig. 6-5) a little and, turning the pressure regulator on its bolts, establish a light contact between the lever and piston 3.

Holding the regulator in this position, tighten bolts 1 and 2 as far as they will go and apply a thin coat of ЛТ-1 grease to axle 6 and to the protruding part of piston 3. Pack 5-6 g of the same lubricant into rubber boot 5 and put it back in position.

Remove fixture 67.7820.9519 and connect the end of the lever with link 7.

Bleeding Hydraulic Brake System

The air getting into the hydraulic brake system during replacement of the pipes, hoses, sealing rings or through loose joints increases free travel of the brake pedal, causes it to feel spongy and impairs the braking effect considerably.

Prior to bleeding the system, make sure that all the units of the brake operating mechanism and their joints are pressure-tight, check the amount of fluid in the reservoir and top it up, if necessary, with brake fluid РОСА ("Роса") or ТОМ ("Томь"). Then clean the bleeder unions carefully of dirt and dust and remove the rubber boots from them.

Put a rubber bleeding hose (Fig. 6-7) on the head of the union and dip the other end of the hose into a transparent vessel partly filled with the brake fluid.

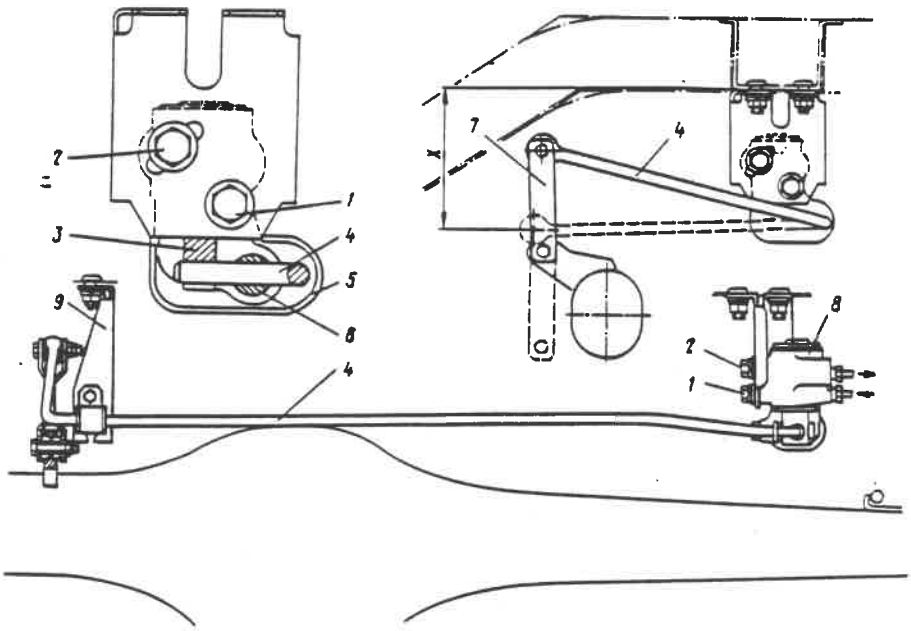


Fig.6-5. Installation and Adjustment of Rear Brake Pressure Regulator:
1,2 - regulator fastening bolts; 3 - piston; 4 - regulator operating lever; 5 - boot; 6 - axle; 7 - link; 8 - pressure regulator; 9 - supporting bushing bracket; X = (150±5) mm

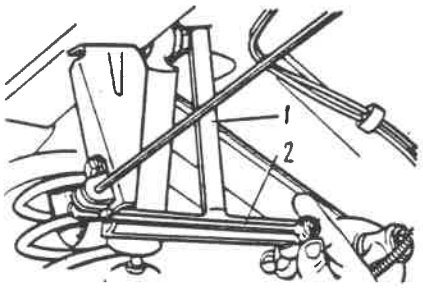


Fig.6-6. Fixture 67.7820.9519 for Rear Brake Pressure Regulator Adjustment:
1 - fixture 67.7820.9519; 2 - pressure regulator operating lever

Depress the brake pedal sharply 3-5 times with 2-3 s intervals between successive depressions, unscrew the union $\frac{1}{2} - \frac{3}{4}$ of a revolution with the pedal depressed; then keep depressing the pedal to remove the fluid with air from the system through the hose into the vessel. As soon as the pedal reaches its foremost position and the fluid ceases to flow from the hose, screw in the bleeder union all the way. Repeat these operations until the fluid flowing from the hose becomes free of air bubbles. Holding the pedal depressed, screw in the bleeder union all the way and remove the hose. Wipe dry the bleeder union and put in place the rubber boot.

Perform all the above operations through the upper unions starting from the rear R.H. wheel

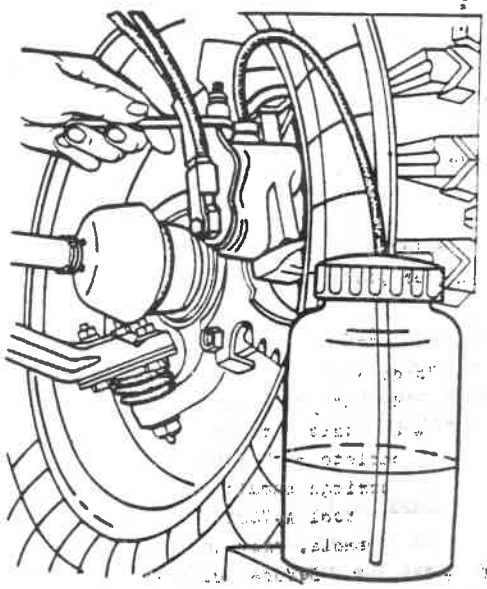


Fig.6-7. Bleeding Hydraulic Brake System

which is farthest from the master cylinder, then proceed in the clockwise direction, i.e. L.H. rear wheel, L.H. and R.H. front wheels. This will expel air from one of the brake circuits. Bleed the other circuit through the lower unions on the block of the cylinders of the L.H. and R.H. front brakes. Bleeding may be started either from the R.H. or L.H. wheel.

While bleeding the hydraulic brake system, take care to maintain a normal fluid level in the brake fluid reservoir. If there is no air in the hydraulic brake system, the brake pedal should not move by more than through $\frac{1}{2}$ - $\frac{3}{4}$ of its travel.

To exclude the influence of the vacuum booster and pressure regulator on the bleeding operation, do it with the engine shut down and the rear wheels loaded (do not jack up the rear end of the car).

If the hydraulic system has been completely drained, the bleeding operation should be preceded by the following:

- unscrew the bleeder unions 1.5-2 revolutions on the brake cylinders of all wheels;
- pressing the brake pedal sharply and releasing it slowly, screw in the unions as the fluid has flowed out. Then bleed the system as described above.

If the air bubbles continue to emerge from the hose even after prolonged bleeding, it means that air enters the system through damaged pipes, leaky joints or faulty master or wheel cylinders.

If the hydraulic system is being bled on the car whose brake system has been operating for a long time, it is recommended that the system be filled with fresh fluid.

The fluid considered fit for reuse should be carefully filtered and settled in a tightly closed vessel.

CLUTCH AND BRAKE PEDAL BRACKET

Removal and Installation

To remove the pedal bracket:

- take off the steering shaft bracket as advised under "Steering gear";
- detach the vacuum booster pushrod from the brake pedal by removing locking clip 26 (Fig. 6-8) and pin 24;
- disconnect the wires from the stop light switch;
- unscrew the nuts which fasten the vacuum booster and pedal brackets to the body front dash panel and remove the bracket complete with the vacuum booster and the brake master cylinder, and then the bracket complete with the clutch and brake pedals.

To install the bracket, reverse the removal operations seeing that the pushrod is properly installed in the socket on the clutch master cylinder piston.

Disassembly and Assembly

To disassemble, remove clutch pedal servo spring 14, return springs 8 and 17, unscrew nut 2 of bolt 20, take out the bolt and remove the pedals complete with their bushings.

The springs should be removed and installed by means of tool A.70017.

To assemble, proceed with the reverse sequence of operations. Before assembly, apply Литол-24 grease to the pedal bushings, the ends of the springs, the joints of the pushrods with the pedals and to the end of the pushrod contacting the piston of the clutch master cylinder.

Checks and Repairs

If the pedals move with difficulty examine the working surfaces of the pedals, bushings and shaft.

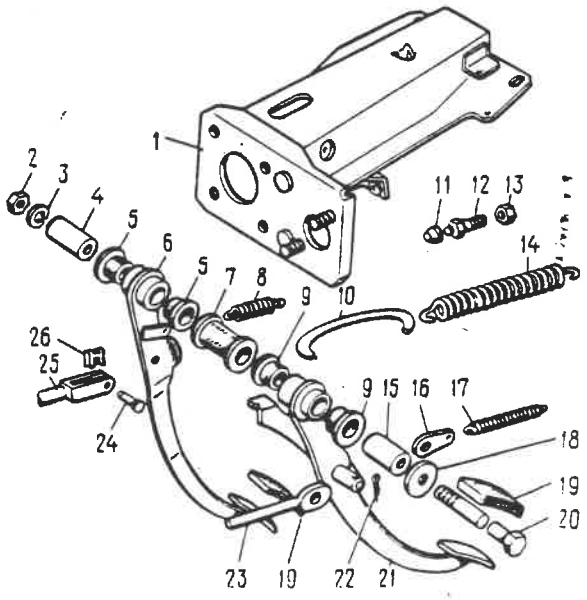


Fig.6-8. Parts of Clutch and Brake Pedals Bracket:
1 - bracket; 2 - nut; 3 - spring washer; 4 - brake pedal inner bushing; 5 - brake pedal outer bushings; 6 - brake pedal; 7 - spacer bushing; 8 - brake pedal return spring; 9 - clutch pedal outer bushings; 10 - hook; 11 - cap; 12 - clutch pedal stop screw; 13 - nut; 14 - servo spring; 15 - clutch pedal inner bushing; 16 - plate; 17 - clutch pedal retracting spring; 18 - washer; 19 - pedal pads; 20 - bolt; 21 - clutch pedal; 22 - cotter pin; 23 - clutch pedal pushrod; 24 - pin; 25 - pushrod; 26 - locking clip

If the metal parts are found to be lightly scratched or oxidized, it is enough to dress them with abrasive cloth; the outer plastic bushings of

the pedals, if worn, should be replaced by new ones.

Check the springs for resilience. The length of the brake pedal spring should be 80 mm under a force of 12.8±1.96 N (1.3±0.2 kgf) and 160 mm under a force of 117.5±5.88 N (12±0.6 kgf).

The length of the clutch pedal retracting spring should be 130 mm under a force of 36.26-30.38 N (3.7-3.1 kgf) and 155 mm under a force of 49.49-42.63 N (5.05-4.35 kgf). The length of the clutch servo spring should be 120 mm under a force of 219.52-180.32 N (22.4-18.4 kgf) and 152 mm under a force of 645.82-529.22 N (65.9-53.9 kgf).

VACUUM BOOSTER

Removal and Installation

When removing the vacuum booster, leave the brake master cylinder in place to prevent air from getting into the hydraulic system.

To remove the booster:

- disconnect the booster pushrod from the pedal;
- unscrew the nuts which fasten the master cylinder to the booster, take the cylinder off the studs and move it aside;
- disconnect the hose from the booster;
- turn off the nuts holding the vacuum booster bracket to the body front dash panel and remove the booster complete with the bracket.

To install the booster, reverse the removal operations.

BRAKE MASTER CYLINDER

The design of the master cylinder is shown in Fig. 6-9.

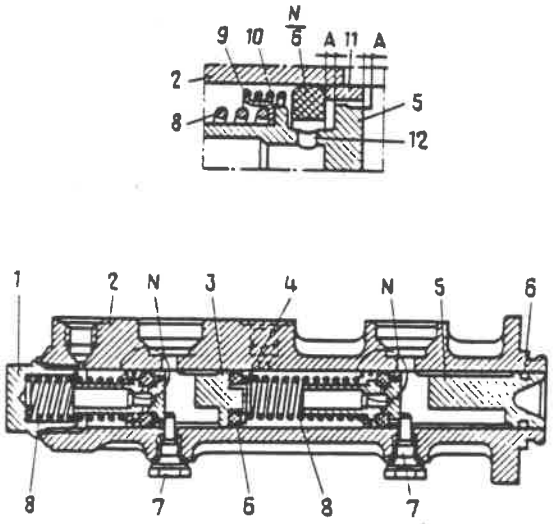


Fig.6-9. Brake Master Cylinder:
1 - plug; 2 - cylinder barrel; 3 - front brake control piston; 4 - washer; 5 - rear brake control and front brake auxiliary control piston; 6 - sealing ring; 7 - stop screw; 8 - piston return springs; 9 - spring seat; 10 - seal hold-down spring; 11 - spacer ring; 12 - inlet hole; A - compensating hole (clearances between sealing ring 6, ring 11 and piston 5)

Removal and Installation

Disconnect the flexible hoses from the master cylinder and stop the holes of the cylinder hoses and unions to keep the fluid in the reservoir and prevent ingress of dust and dirt.

Disconnect from the master cylinder the steel pipes leading to the wheel cylinders of the front and rear brakes, first unscrewing the pipe nuts.

Remove the master cylinder, unscrewing the nuts which fasten it to the vacuum booster.

To install the master cylinder, reverse the removal operations. After installation, bleed the brake system.

Disassembly and Assembly

Remove unions 2 (Fig. 6-10) complete with connecting bushings 3, turn out stop bolts 5 and take out all parts as shown in Fig. 6-10.

Assemble the cylinder in the reverse order, using mandrel 67.7853.9543 and lubricating the parts with brake fluid.

Checking Master Cylinder Parts

Before assembly wash all parts with isopropyl alcohol, dry them with compressed air or wipe with a clean cloth, keeping the parts out of contact with mineral oils, kerosene or diesel fuel which are apt to attack the seals.

Note. The washing time of the sealing rings in isopropyl alcohol should not be over 20 s, with subsequent blowing the rings with compressed air.

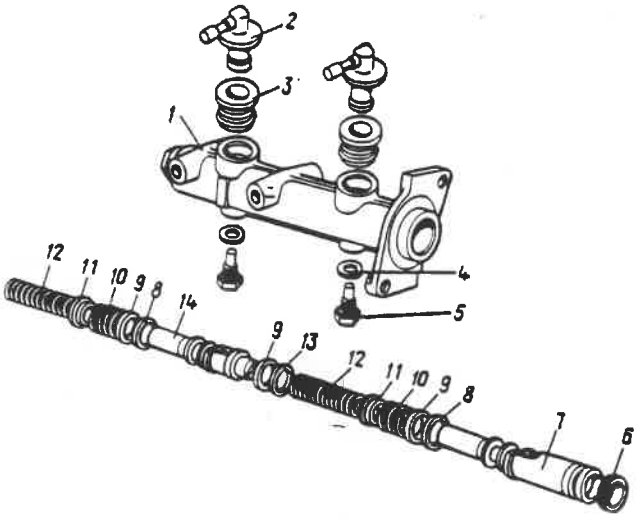


Fig.6-10. Parts of Brake Master Cylinder:
1 - cylinder barrel; 2 - union; 3 - connecting bushing; 4 - sealing washer; 5 - stop bolt; 6,9 - sealing rings; 7 - rear brake control and front brake auxiliary control piston; 8 - spacer ring; 10 - sealing ring hold-down spring; 11 - spring seat; 12 - piston return spring; 13 - washer; 14 - front brake control piston

The cylinder inner face and the working surfaces of the pistons should be perfectly clean and free of rust, notches and other defects. Excessive clearance between the cylinder and pistons is impermissible.

Each time when disassembling the cylinder, take care to replace the seals by new ones, even if the old seals appear to be quite serviceable.

Check the piston springs for resilience; the length of the spring should be 41.7 mm under a load of 42.18±3.92 N (4.3±0.4 kgf), 21 mm under a load of 90.64±8.83 N (9.24±0.9 kgf) and 59.7 mm in a free state.

Brake Master Cylinder Tightness Check

Mount the master cylinder on a stand and connect it to the latter as shown in Fig. 6-11.

Open stand priming valves 1 and, moving the master cylinder pistons several times through their complete stroke, prime the system. Then close valves 1. Rotating handwheel 5, move the master cylinder pistons slowly until the pressure read by pressure gauges 2 reaches 12.5 MPa (125 kgf/cm^2). In this position lock the master cylinder pushrod. This pressure should stay constant for at least 5 s.

In case of fluid leaks or when pressure fails to remain constant for 5 s, replace the cylinder piston seals.

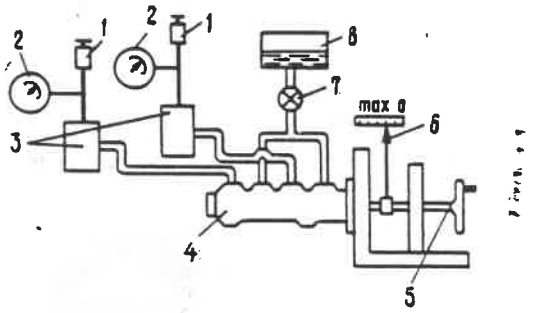


Fig.6-11. Checking Master Cylinder for Tightness:
1 - stand priming valve; 2 - pressure gauge; 3 - receiving cylinder; 4 - master cylinder; 5 - handwheel; 6 - pushrod travel indicator; 7 - cock; 8 - vessel

FRONT BRAKES

The design of the front brake is illustrated in Fig. 6-12.

Cleaning

Prior to repairing the brakes, wash them thoroughly with warm water and a special detergent and dry immediately with compressed air.

Caution:

Under no circumstances should gasoline, diesel fuel, trichloroethylene or any other mineral solvents be used for cleaning the brakes since these liquids destroy cylinder seals.

Removal and Installation

Removal. Jack up the front end of the car, put it on supports and remove the wheel.

Take off the guide brackets of the hoses. Unscrew the bypass bolts, detach hoses 10 (Fig. 6-12) from the cylinder block, keeping dirt from getting into the cylinders. Stop the inlet holes of the cylinder block and hoses.

Unbend the edges of the front brake guard, unscrew the brake-to-steering-knuckle bolts (Fig. 6-13) and remove the brake as a complete unit.

Install the front brake in the reverse order.

After installation, restore the fluid level in the reservoir and bleed the brake system.

Disassembly and Assembly

Pull out the cotter pins and then axles 5 (Fig. 6-12), holding levers 3 to prevent the springs from getting out.

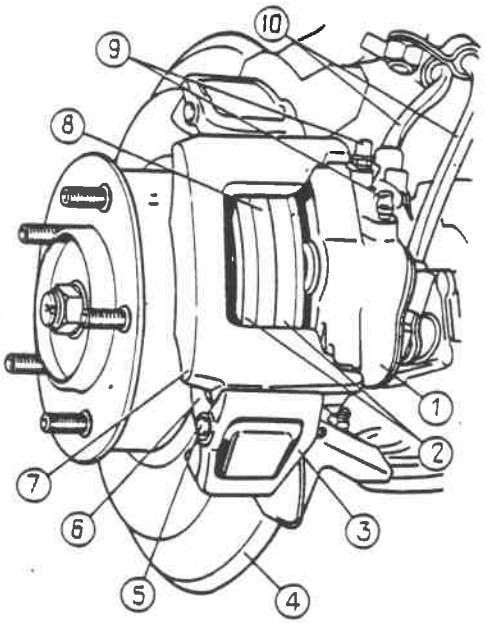


Fig.6-12. Front Wheel Brake Mechanism:
1 - cylinder block; 2 - brake shoes; 3 - caliper hold-down lever; 4 - guard housing; 5 - hold-down lever axle; 6 - shoe guide; 7 - brake caliper; 8 - brake disc; 9 - bleeder unions; 10 - brake hoses

Fig.6-13. Removing Front Brake.
Arrows show bolts to be unscrewed for removing brake

Remove the hold-down levers and their springs, then caliper 7 complete with cylinder block 1. Remove brake shoes 2.

Take cylinder block 1 from the slots in the caliper, spreading apart the caliper slots to 118.5 mm and pressing on detent 12 (Fig. 6-14). Remove dust caps 3 from the cylinders.

Feeding compressed air through the fluid inlet hole, push pistons 14 out of the cylinder block and remove sealing rings 4.

Assemble the front brake in the reverse sequence, coating the sealing rings, pistons and cylinder faces with brake fluid at assembly; pack the caps with ЛТ-1 grease.

Checking Brake Parts

Wash all parts with lukewarm water and detergent, dry them with compressed air and examine carefully.

If traces of wear or jamming are discovered on the pistons or cylinder faces, replace the cylinder block by a new one complete with pistons.

Note. In all cases when the piston is removed from the cylinder, it is good practice to replace the sealing rings in the cylinder grooves and the dust cap to ensure satisfactory performance of the system.

Runout Check of Brake Disc

Check the brake disc for face runout without removing it from the car (Fig. 6-15). The maximum permissible runout is 0.15 mm shown by an indicator; if it is greater, grind the disc, bearing in mind that the thickness of the disc after grinding should be not under 9.5 mm. If the disc is damaged, deeply notched or worn in excess of 1 mm on each side, replace it by a new one.

Replacement of Brake Shoes

The brake shoes must be replaced by new ones if the thickness of the linings has diminished to 1.5 mm.

To replace the shoes:

- uncotter the axle of the upper hold-down lever, take out the axle and remove the lever; remove the caliper assembly and pull the worn shoes from the slots of the guide (Fig. 6-15);
- push the pistons gently into the cylinders all the way, taking care that the fluid is not splashed out of the brake master cylinder reservoir and insert new shoes into the guide slot.
- bringing the lower guide slant of the caliper under the lower hold-down lever, press the caliper against the shoes, insert the lever axle with its head at the wheel side and cotter up the axle.

The brake shoes must be replaced simultaneously on the R.H. and L.H. wheels.

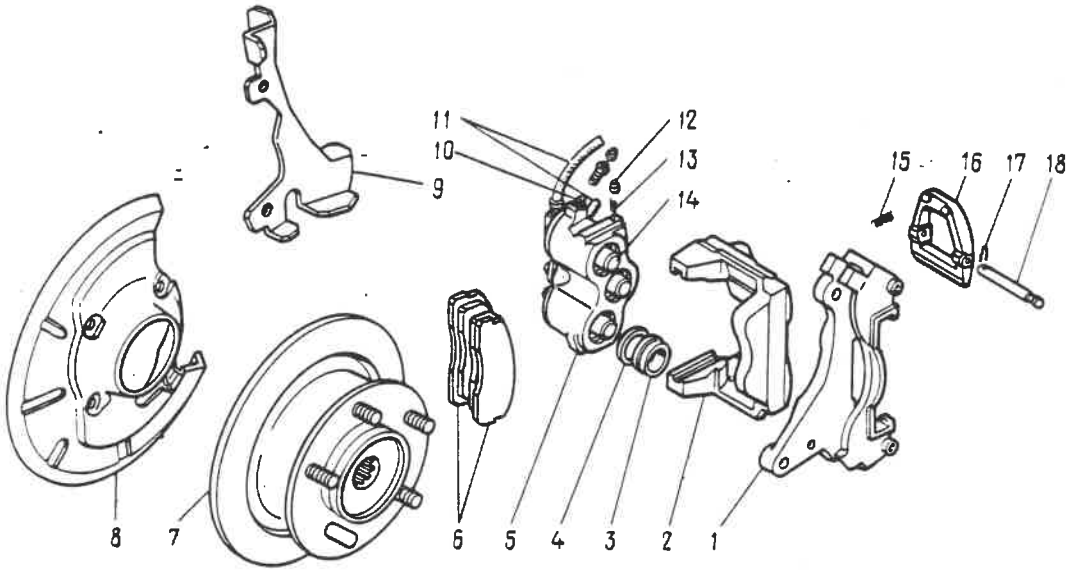


Fig.6-14. Front Brake Parts:
1 - shoe guide; 2 - brake caliper; 3 - dust cap; 4 - sealing ring; 5 - cylinder block; 6 - brake shoes; 7 - brake disc; 8 - front brake guard housing; 9 - caliper guard; 10 - bleeder union; 11 - brake hoses; 12 - cylinder block detent; 13 - detent spring; 14 - piston; 15 - hold-down lever spring; 16 - hold-down lever; 17 - cotter pin; 18 - hold-down lever axle

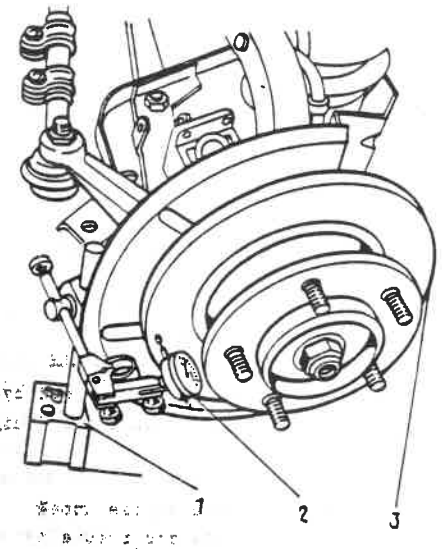


Fig.6-15. Checking Brake Disc for Face Runout:
1 - magnetic support; 2 - indicator; 3 - brake disc

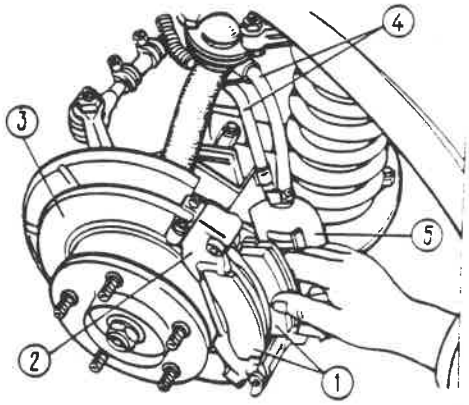


Fig.6-16. Replacing Brake Shoes:
1 - brake shoes; 2 - shoe guide; 3 - brake disc; 4 - brake hoses; 5 - cylinder block (assembled with caliper)

REAR BRAKES

The design of the rear brake is illustrated in Fig. 6-17.

Removal and Disassembly

Lift the rear end of the car and remove the wheel.

Take measures to prevent fluid leaks from the reservoir.

Using remover 67.7823.9519 (Fig. 6-18), remove the brake drum.

Disconnect the end of the cable (Fig. 6-17) from shoe hand-operated lever 18, pull out the cotter pin, press on pin 21 and take off lever 18. Disconnect upper and lower pull-back springs 2 and 7, respectively. Turn the cups of shoe guides 17 and take them out complete with the shoe guides,

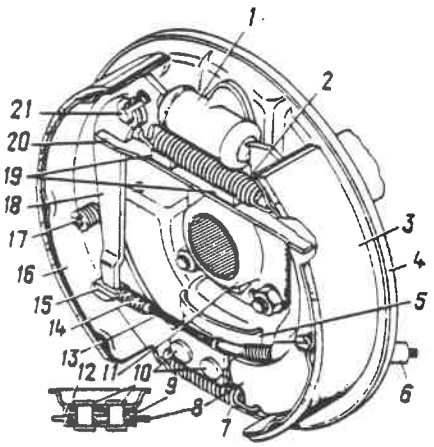


Fig.6-17. Rear Brake Mechanism:
1 - wheel cylinder; 2 - upper pull-back spring; 3 - shoe friction lining; 4 - brake backing plate; 5 - inner plate; 6 - rear cable sheathing; 7 - lower pull-back spring; 8 - front brake shoe; 9 - shoe supporting plate; 10 - rivet; 11 - oil deflector; 12 - shoe guide plates; 13 - parking brake rear cable; 14 - rear cable spring; 15 - rear cable end-piece; 16 - rear brake shoe; 17 - shoe guide; 18 - shoe hand-operated lever; 19 - rubber pads; 20 - expander strap; 21 - shoe hand-operated lever pin

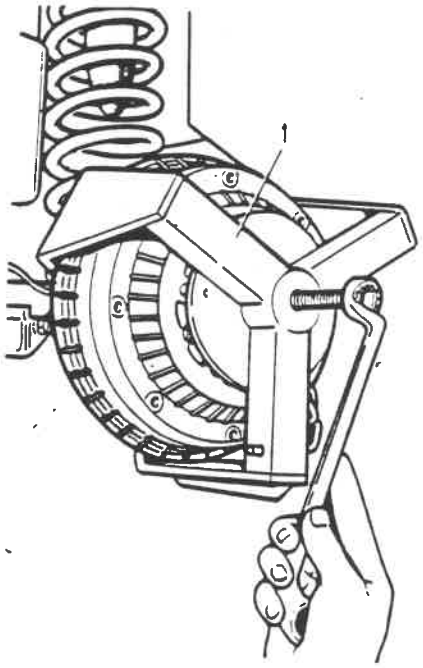


Fig.6-18. Removing Brake Drum:
1 - remover 67.7823.9519

springs and lower cups; then remove shoes 8 and 16 complete with expander strap 20.

Detach the fluid feed pipe from wheel cylinder 1 and stop the inlet holes of the cylinder and pipe.

Remove the wheel cylinder.

When replacing brake backing plate 4, take off the axle shaft as prescribed under "Rear Axle" and disconnect parking brake rear cable 13, unscrewing two bolts which hold it to brake backing plate 4.

Assembly and Installation

Mount and secure the wheel cylinder on the backing plate, connect the fluid inlet pipe to it and tighten home the union nut.

Connect hand-operated lever 18 (Fig. 6-17) to the shoe and install the brake shoes with expander strap 20, then install shoe guides 17 with springs and lower cups, install the upper cups and secure them to the shoe guides by turning to the right or to the left. Make sure that the ends of the brake shoes fit properly into the sockets of the wheel cylinder piston stops and on the backing plate.

Connect endpiece 15 of the parking brake rear cable to lever 18.

Install the brake drum, first coating the mounting band on the axle shaft with graphite or ЛСЦ-15 grease and tighten the drum bolts securely.

Disassembly and Assembly of Wheel Cylinders

The procedure is as follows:

Remove boots 2 (Fig. 6-19) and press piston 4 complete with the parts of the shoe-to-brake drum automatic clearance adjustment device out of cylinder barrel 3.

Place the piston complete with the automatic clearance adjustment device in a fixture so that the projections of the fixture should embrace the head of thrust screw 3 (Fig. 6-20). By turning piston 9 with a screwdriver, turn thrust screw 3 out of the piston. Remove seal 8 with spring seat and locks 5 from the screw. Separate thrust ring 4 and thrust screw 3.

To assemble the automatic clearance adjustment device and the wheel cylinder proper proceed in the order reverse to disassembly taking into account the following:

- tighten the thrust screws of the pistons to a torque of 4-7 N.m (0.4-0.7 kgf.m);
- slot A (Fig. 6-19) on the thrust rings should point vertically upwards; maximum tolerable deflection from the vertical is 30°. Such a position of the slot provides complete evacuation of air from the brake mechanism at bleeding;
- to provide preliminary compression of the thrust rings press-fit the pistons into the cylinder barrel using a special tool in the form of a cylinder with a taper inner hole;

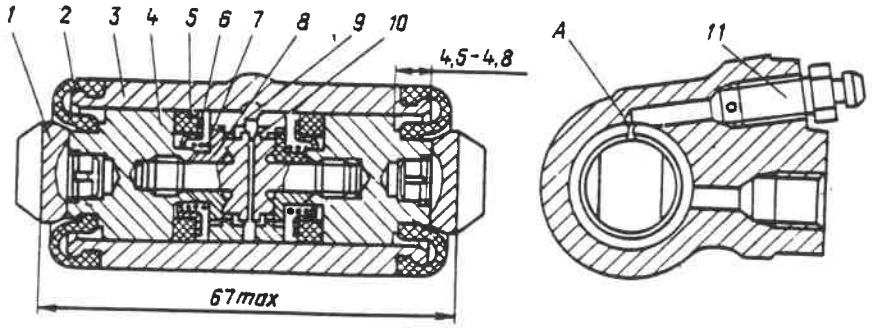


Fig.6-19. Wheel Cylinder:
1 - shoe abutment; 2 - boot; 3 - cylinder barrel;
4 - piston; 5 - seal; 6 - spring seat; 7 - spring;
8 - locks; 9 - thrust ring; 10 - thrust screw;
11 - union; A - slot on thrust ring

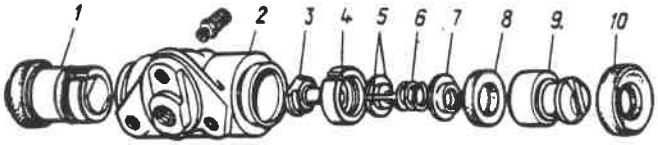


Fig.6-20. Wheel Cylinder Parts:
1 - piston assembly; 2 - cylinder barrel;
3 - thrust screw; 4 - thrust ring; 5 - locks;
6 - spring; 7 - spring seat; 8 - seal; 9 - piston;
10 - boot

- force of press-fitting of the piston into the cylinder should be not less than 350 N (35 kgf); if the force is less than 350 N (35 kgf) replace the thrust ring;

- when press-fitting the piston into the cylinder maintain the sizes of 4.5-4.8 mm and 67 mm (maximum) (Fig. 6-19) to provide free fitting of the brake drum;

- prior to installing the parts in the cylinder barrel lubricate them liberally with brake fluid.

After assembly check free travel of each piston in the cylinder barrel. The pistons should travel easily within 1.25 and 1.65 mm. Boots 2 are the last to be installed.

Inspection of Parts

Wheel cylinders. Check cleanliness of the working surfaces of the cylinder, pistons and thrust rings. The surfaces should be perfectly smooth, without roughness, to prevent leakage of fluid and untimely wear of the seals and pistons. Eliminate defects on the cylinder face by lapping or grinding, but take care not to increase the cylinder bore.

Check condition of thrust screw 3 (Fig.6-20), spring 6, spring seat 7 and locks 5. If necessary, replace defective parts with new ones.

Replace seals 8 by new ones. Check condition of boots 10 and, if necessary, replace them.

Shoes. Inspect the shoes carefully for damage and distortion.

Check both the upper and lower pull-back springs for resilience and replace them by new ones, if necessary.

There should be no permanent deformations after the lower and upper springs have been stretched by a force of 350 N (35 kgf) and 420 N (42 kgf), respectively.

Check the linings for cleanliness; if dirt or oil traces are discovered, clean them thoroughly with a wire brush and wash with white spirit; besides, look for penetration of lubricant or oil into the drum; correct any discovered defects.

Replace the shoes by new ones if the thickness of their linings is less than 1.5-2 mm.

Brake drums. Examine the brake drums. If the working surface is deeply scored or excessively out of round, rebore the drums in a lathe.

After reboring, finish the working surface of the drum in a lathe with fine-grain abrasive stones. This will extend the service life of the linings and improve the uniformity and efficiency of braking.

The nominal diameter of the drum (250 mm) after reboring and grinding should not be increased

by more than 1 mm. This limit should be strictly observed, otherwise, the strength of the drum and the braking efficiency will be impaired.

Stand Checks of Rear Brake Wheel Cylinders

Mount cylinder 2 (Fig. 6-21) on the stand, connect a pipe from the pressure gauges to it and bleed the system.

Adjust stops 1 so that they bear against the wheel cylinder pistons.

Check for absence of fluid leaks. Connect low pressure gauge 4; rotating slowly handwheel 8 of the stand, set a fluid pressure to 0.05 MPa (0.5 kgf/cm^2) as read by pressure gauge 4.

Make sure that this pressure remains constant for 5 min. Repeat a similar test under a pressure of 0.1, 0.2, 0.3, 0.4 and 0.5 MPa (1, 2, 3, 4 and 5 kgf/cm^2).

Reduce the pressure and connect high-pressure gauge 5. Observing the above rules, repeat the tests under a pressure of 5, 10 and 15 MPa (50, 100 and 150 kgf/cm^2).

There should be no pressure drop caused by fluid leaks past the sealing elements, pipe joints and bleeder unions or through the casting pores.

A slight pressure drop (not over 0.5 MPa (5 kgf/cm^2) within 5 min) is permissible, particularly at high pressure, when it is caused by the shrinkage of the seals.

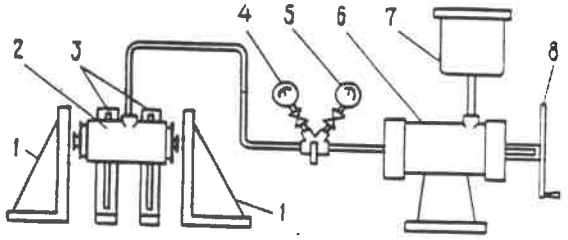


Fig.6-21. Rear Wheel Cylinder Checking Setup: 1 - piston stops; 2 - cylinder under test; 3 - cylinder bracket; 4 - low-pressure gauge; 5 - high-pressure gauge; 6 - pressure build-up cylinder; 7 - vessel; 8 - handwheel

REAR BRAKE PRESSURE REGULATOR

Removal and Installation

Disconnect lever 12 (Fig. 6-22) from link 7, then detach holder 18 from bracket 14 and the clamps of the pipes leading to the pressure regulator.

Disconnect the muffler mounting parts from the car body and move aside the pipeline with the mufflers.

Unscrew the regulator-to-bracket and bracket-to-body bolts. Remove the regulator bracket, ease down the regulator and disconnect its pipes.

Remove the regulator and detach its operating lever. Stop the inlet and outlet holes of the pressure regulator and pipes.

To install the pressure regulator, reverse the removal operations. Before tightening the regulator bolts, install fixture 67.7820.9519 (Fig. 6-6) at the end of the regulator operating lever. Direct the fixture spindle upward to bear against the car body. This will set a distance of (150±5) mm (see under "Adjusting Position of Pressure Regulator") between the end of lever 12 and the body side member.

Lift boot 3 (Fig. 6-22) a little and, turning the regulator on its bolts, bring the end of the lever in light contact with the regulator piston.

Holding the regulator in this position tighten its fastening bolts all the way, then apply a coat

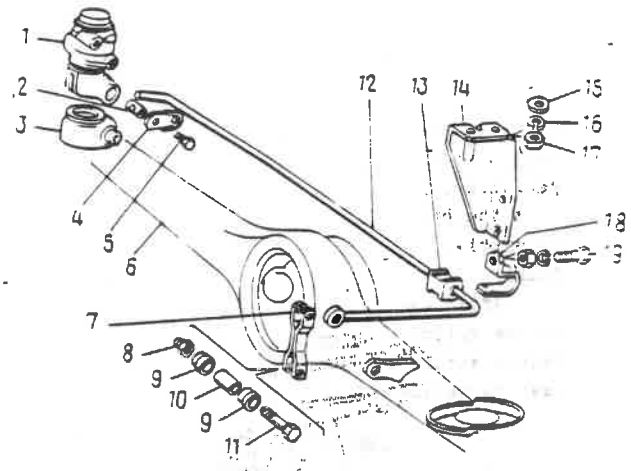


Fig.6-22. Pressure Regulator Control Linkage: 1 - pressure regulator; 2 - pressure regulator operating lever axle; 3 - boot; 4 - locking plate; 5 - bolt with spring washer; 6 - rear axle beam; 7 - link from pressure regulator operating lever to rear axle bracket; 8 - washer of bolt 11; 9 - plastic bushing; 10 - spacer bushing; 11 - link bolt; 12 - pressure regulator operating lever; 13 - operating lever supporting bushing; 14 - supporting bushing bracket; 15 - washer; 16 - spring washer; 17 - nut; 18 - supporting bushing holder; 19 - holder-to-bracket bolt

of ЛТ-1 grease to axle 2 and to the protruding part of the piston. Put rubber boot 3 in position, having packed 5-6 g of the same grease into the boot.

Remove fixture 67.7820.9519 and connect the end of the lever with link 7, first applying ЛТ-1 grease to the bushings of the link-to-lever articulated joint.

Fasten the exhaust system pipes to the car body.

Bleed the brakes to remove any air from the rear brake system.

Disassembly and Assembly

Using wrench A.56124, unscrew the plug, remove gasket 5 (Fig. 6-23), take out piston 10, spacer bushing 2, seal 7, spring seat 8, spring 9, and thrust washer with sealing ring 3.

To assemble, reverse the disassembly operations, lubricating all parts with brake fluid.

Caution:

The pressure regulator of the VAZ-2121 and VAZ-21213 cars has a recess in the lower part of the piston, to distinguish it from the like regulators of other car models.

Wash the parts with isopropyl alcohol or brake fluid and inspect them. The surfaces of the parts should be free of scratches and rough spots.

Check the condition and resilience of the spring; its free length should be 17.8 mm and under a load of 76.44-64.68 N (7.8-6.6 kgf), 9 mm.

Replace all damaged parts, the seal and the sealing ring.

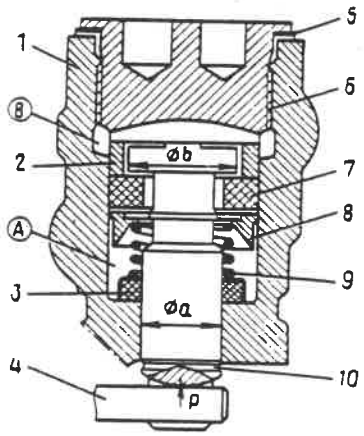


Fig.6-23. Rear Brake Pressure Regulator (Inactive Position):
A - normal pressure chamber; B - controlled pressure chamber; P - force exerted by regulator lever 4
1 - regulator body; 2 - spacer bushing; 3 - sealing ring; 4 - regulator operating lever; 5 - gasket; 6 - plug; 7 - rubber seal; 8 - spring seat; 9 - piston spring; 10 - piston

PARKING BRAKE

Removal and Installation

Shift the parking brake lever to the downmost position and disconnect the ends of the cables from the brake shoe operating levers (see "Rear Brakes").

Loosen locknut 5 (Fig. 6-4) and adjusting nut 6, remove return spring 9 (Fig. 6-24) and unscrew completely the locknut and the nut.

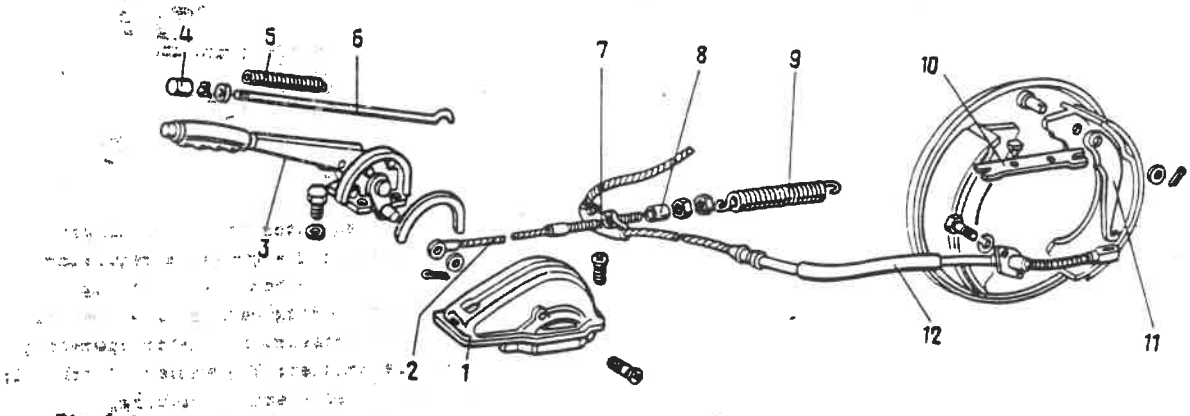


Fig.6-24. Parking Brake Control Linkage Parts:
1 - case; 2 - front cable; 3 - lever; 4 - button; 5 - rod spring; 6 - pawl rod; 7 - rear cable guide; 8 - spacer bushing; 9 - return spring; 10 - expander strap; 11 - shoe hand-operated lever; 12 - rear cable

Take the front endpieces of the rear cable from the body floor brackets, and the cable sheathing out of the brackets on the rear axle beam, and remove rear cable 12.

Take off the lever guard case, the lever assembly and the front cable.

Pull out the cotter pin, take off the thrust washer and disconnect the front cable from the parking brake lever.

To install the parking brake, reverse the removal operations, then adjust it (see "Adjustment of Parking Brake"). During installation, apply ЛИТОЛ-24 or ЛСЦ-15 grease to the rear cable guide, parking brake lever axle and front cable endpiece.

Checks and Repairs

Inspect the parking brake parts carefully.

Replace the cable if its strands are broken or chafed.

Make sure that the quadrant teeth and the handle latches are intact; replace excessively worn parts.

Check the condition of the spring. It must return the lever reliably to the off position.

Examine the sheathing of the rear cable and the fastening of the endpieces to the sheathing and make sure that the cable is free to slide inside the sheathing. Replace the cable if its sheathing is damaged or the endpieces are loose.

Section VII

ELECTRICAL EQUIPMENT

WIRES AND FUSES

The electrical equipment is of the single-wire ground-return type with the negative terminals of the power sources and consumers connected to "ground" which functions as the second wire.

The car electrical equipment circuit diagram is shown in Fig. 7-1.

The majority of the circuits are energized through the ignition switch. The circuits which are alive irrespective of the position of the ignition key are: horn, stop light, cigarette lighter, interior lamps, inspection lamp socket circuits as well as distress light, external lighting and headlight upper beam signalling circuits.

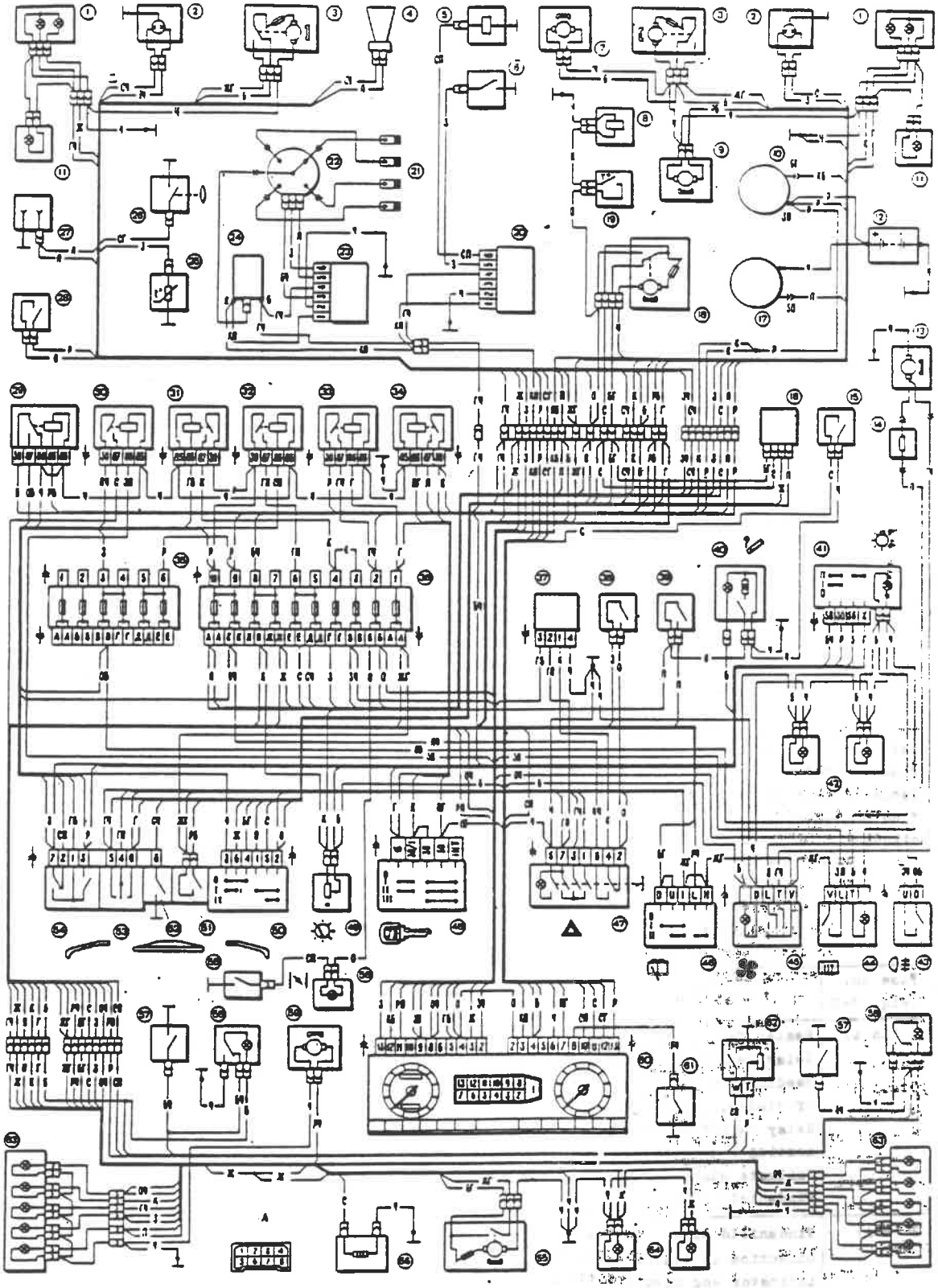
The majority of the electrical equipment circuits of the car is protected by fuses (Fig. 7-2) located under the instrument panel, to the left from the steering column. The battery charging circuit, headlight lower and upper beam relays, ignition and engine starting circuits are not protected by fuses. Fuses 11, 12, 14, 15, 16 installed in the auxiliary fuse unit are vacant. They are used in various car versions.

If a fuse is blown, first identify and eliminate the cause of the trouble, then replace the fuse. To trace down the faulty spot, refer to the table of fuse-protected circuits (Table 7-1) to find out which particular fuse protects the given circuit.

Table 7-1

Fuse-Protected Circuits

Fuse No. (Fig. 7-2)	Circuits
1 (16 A)	Heater fan motor. Relay (winding) of headlight wipers and headlight wiper motors in all positions of blades, except initial position. Relay (winding) of tailgate glass heating. Tailgate glass wiper and washer motors. Windshield washer motor.
2 (8 A)	Windshield wiper relay and motor. Direction indicator lamps and direction indicator and distress light flasher (in direction indicating mode). Direction indicator warning lamp. Tail lights (backing light lamps). Alternator field winding (at engine starting). Differential lock warning lamp. Parking brake relay-breaker and warning lamp. Brake fluid low level warning lamp. Oil pressure warning lamp. Coolant temperature gauge. Fuel level gauge with low fuel level warning lamp. Voltmeter. Tachometer.
3 (8 A)	L.H. headlight (upper beam). Headlight upper beam warning lamp.
4 (8 A)	R.H. headlight (upper beam).
5 (8 A)	L.H. headlight (lower beam).
6 (8 A)	R.H. headlight (lower beam).
7 (8 A)	L.H. front light (marker light). R.H. rear light (marker light). Number plate lights. Marker light warning lamp.
8 (8 A)	R.H. front light (marker light). L.H. rear light (marker light). Instrument cluster illumination lamps. Heater control levers illumination panel. Cigarette lighter illumination lamp. Switch illumination lamp.
9 (16 A)	Direction indicators and direction indicator and distress light flasher in distress lighting mode. Tailgate glass heating element and its cut-in relay (contacts).
10 (16 A)	Horn. Inspection lamp socket. Interior lamps. Tail lights (stop-light lamps). Cigarette lighter.



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Fuse No. (Fig.7-2)	Circuits
13 (8 A)	Tail lights (fog light). Headlight wiper motors at moment of starting and when passing through initial position. Headlight wiper relay (contacts). Headlight washer motor.

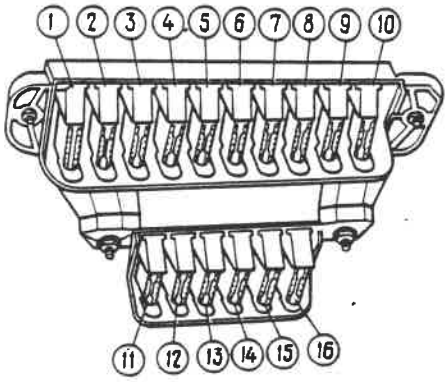

Fig. 7-2. Fuses

In all the diagrams of the "Electrical Equipment" Section the colour of the wires is denoted by letters, the first letter standing for the colour of the wire, while the second one denotes the colour of the wire tracer (Table 7-2).

Table 7-2

Wire Colour Code

Letter	Colour	Letter	Colour
Б	White	О	Amber
Г	Blue	К	Red
Ж	Yellow	Р	Pink
З	Green	С	Gray
К	Brown	Ч	Black

Warning:

When repairing the car and its electrical equipment system do not fail to disconnect the wire from the MINUS terminal of the storage battery.

In service and when checking the electrical equipment DO NOT use fuses other then those recommended by the Manufacturer.

Fig.7-1. Wiring Diagram of Cars VAZ-21213:
1 - side lights; 2 - headlights; 3 - headlight wiper motors; 4 - horn; 5 - carburettor electromagnetic valve; 6 - carburettor limit switch; 7 - headlight washer motor; 8 - carburettor cold starting unit electropneumatic valve; 9 - windshield washer motor; 10 - alternator; 11 - side direction indicators; 12 - storage battery; 13 - heater motor; 14 - heater motor series resistor; 15 - differential lock warning lamp switch; 16 - windshield wiper relay-breaker; 17 - starter; 18 - windshield wiper motor; 19 - thermal switch of electropneumatic valve 8; 20 - carburettor electromagnetic valve control unit; 21 - spark plugs; 22 - ignition pickup-distributor; 23 - transistor switch; 24 - ignition coil; 25 - temperature transmitter; 26 - oil pressure warning lamp transmitter; 27 - inspection lamp socket; 28 - brake fluid low level warning lamp switch; 29 - headlight wiper and washer relay; 30 - tailgate glass heating relay; 31 - headlight upper beam relay; 32 - headlight lower beam relay; 33 - ignition relay; 34 - starter cut-in relay; 35 - additional fuse unit; 36 - main fuse unit; 37 - direction indicators and distress light flasher; 38 - backing light switch; 39 - stop light switch; 40 - cigarette lighter; 41 - external lighting switch; 42 - heater control levers illumination lamps; 43 - tail fog light switch; 44 - tailgate glass heating switch; 45 - heater motor switch; 46 - tailgate glass wiper and washer switch; 47 - distress light switch; 48 - ignition switch; 49 - instrument illumination switch; 50 - windshield wiper switch; 51 - windshield washer and headlight wipers and washer switch; 52 - horn switch; 53 - direction indicator switch; 54 - headlight beam switch; 55 - carburettor choke warning lamp switch; 56 - carburettor choke warning lamp; 57 - interior light switches in door pillars; 58 - interior lights; 59 - tailgate glass washer motor; 60 - instrument cluster; 61 - parking brake warning lamp switch; 62 - fuel level and low fuel level transmitter; 63 - tail lights; 64 - number plate lights; 65 - tailgate glass wiper motor; 66 - tailgate glass heating element; А - numbering of plugs in three-lever switch sockets

Specifications

Type	6CT-55A, non-attended
Rated voltage, V	12
Rated capacity at 20-h discharge rate and electrolyte temperature of $(27\pm2)^{\circ}C$ at beginning of discharge, A·h	55
Discharge current at 20-h discharge rate, A	2.75
Discharge current at starting, at electrolyte temperature of 18°C, A	255

Trouble Shooting

Cause	Remedy
Rapid Discharge in Service	
1. Slipping of alternator drive belt	1. Adjust belt tension
2. Alternator faulty	2. Check alternator
3. Damaged insulation in car electrical system (discharge current higher than 11 mA with consumers disconnected)	3. Find and correct defect
4. Short-circuiting of cell plates	4. Replace battery
5. Connection of new consumers by car owner in excess of permissible limits	5. Remove new consumers
6. Electrolyte contaminated by foreign admixtures	6. Discharge battery, drain electrolyte, wash, fill in fresh electrolyte and charge battery
7. Battery surface very dirty	7. Clean battery surface
8. Electrolyte level dropped below upper edge of plates	8. Restore normal electrolyte level
Battery Surface Wetted with Electrolyte	
1. Battery overfilled, electrolyte splashes out	1. Set normal electrolyte level
2. Electrolyte seeping through cracks in battery case	2. Replace battery
3. Violent gassing of electrolyte caused by excessively high alternator voltage	3. Replace voltage regulator
4. "Boiling" of electrolyte caused by sulphation of plates	4. Replace battery

Preparation of Dry-Charged Battery for Use

The cars shipped from the Plant are fitted with storage batteries filled with the electrolyte and charged.

Spare batteries may be delivered in a dry-charged state, without electrolyte.

To prepare for operation a dry-charged stor. battery remove the shipment plugs or sealing tape. Then fill the cells with the electrolyte, specific gravity 1.28 g/cm^3 (corrected to 25°C for temperate climates regions and 1.23 g/cm^3 for tropics pouring the electrolyte in a weak stream through a funnel made of glass or an acid-resistant plastic. All battery activation operations should be carried out at temperatures of $(25\pm10)^{\circ}C$.

Let the plates and separators impregnate for 20 min and then check voltage across the battery under no load.

If the battery voltage is not lower than 12.5 V, the battery is ready for service. If the voltage is less than 12.5 V but is higher than 10.5 V, the battery should be charged to the voltage specified by the manufacturer. If the voltage is 10.5 V or lower, the battery should be discarded.

After the separators and plates have been soaked with electrolyte, its level will drop inevitably. Therefore, prior to installing the battery in the car, bring the electrolyte level to the normal value by adding electrolyte of the same specific gravity as that at the beginning of filling.

The battery should be subjected to charging after filling in the electrolyte if:

- the battery will be operated under heavy conditions: in cold weather, with frequent startings of the engine, etc;
- the battery have been stored for more than 12 months from the date of manufacture.

Checking Electrolyte Level

The electrolyte level in all battery cells should be within MIN and MAX marks on the semi-transparent battery case. Operation of the battery with the electrolyte level below MIN mark is prohibited.

In service the electrolyte level drops gradually due to evaporation of water from electrolyte. To restore the normal level, add distilled water only.

If it is known for certain that the electrolyte level has dropped due to splashing out, top up the battery with electrolyte of the same specific gravity as that of the electrolyte remaining in the cells.

If the level is higher than necessary, remove the surplus quantity using a rubber bulb with an ebonite tip.

Checking State of Charge

If the battery fails in operation and in servicing check the state of charge using a hydrometer. Simultaneously measure the electrolyte temperature to introduce a temperature correction to the hydrometer readings (See Table 7-3). At temperatures of the electrolyte exceeding 30°C the correction value should be added to the hydrometer reading. At temperatures below 20°C, the correction value should be extracted from the hydrometer reading. At the electrolyte temperatures within 20 and 30°C, no temperature corrections should be introduced.

Table 7-3

Temperature Corrections to Hydrometer Readings

Electrolyte temperature	Correction, g/cm^3
from -40 to -26	-0.04
from -25 to -11	-0.03
from -10 to +4	-0.02
from +5 to +19	-0.01
from +20 to +30	0.00
from +31 to +45	+0.01

Having determined the specific gravity of the electrolyte in each cell of the battery, find the state of its charge by referring to Table 7-4. If the battery is discharged by more than 25% in winter and more than 50% in summer, remove it from the car and subject to charging.

Table 7-4

Specific Gravity of Electrolyte at 25 °C, g/cm^3

Climatic region (average monthly air temperature in January, °C)	Season of year	Fully charged battery	Battery discharged	
			by 25%	by 50%
Very cold (from -50 to -30)	Winter	1.30	1.26	1.22
	Summer	1.28	1.24	1.20
Cold (from -30 to -15)	All year round	1.28	1.24	1.20
Temperate (from -15 to -8)	All year round	1.28	1.24	1.20
Warm wet (from 0 to +4)	All year round	1.23	1.19	1.15
Hot dry (from -15 to +4)	All year round	1.23	1.19	1.15

When measuring the specific gravity of the electrolyte take care to prevent drops of electrolyte from getting onto the battery surface, body and other parts of the car as the electrolyte, being a sulphuric acid solution, causes corrosion, current leaks, etc.

DO NOT measure the electrolyte specific gravity:

- if the electrolyte level is not correct;
- if the electrolyte is too hot or cold; the optimum temperature for checking the specific gravity is 15-27°C;
- immediately after adding distilled water. Let the electrolyte mix with water; if the battery is discharged, it can take even several hours;
- after several applications of the starter. Wait to let the specific gravity in the cells level up;
- when the electrolyte is gassing heavily ("boiling"). Wait until air bubbles in the electrolyte in the dropper rise to the surface.

Charging Battery

Remove the battery from the car, clean it thoroughly, particularly on the top, check and if necessary, correct the electrolyte level.

The battery should be charged with 5.5 A current with the plugs turned out. Charge the battery until it starts gassing freely and the voltage and specific gravity remain constant for 3 hours. The specific gravity of the battery electrolyte after charging should be as indicated in Table 7-4, depending on the climatic area. Measurement values should be corrected to 25°C.

When charging the battery periodically check the electrolyte temperature and take care not to let it rise above 40°C. If the temperature reaches 40°C either reduce by half the charging current or stop charging and let the battery cool down to 27°C.

Stop charging when all cells gas freely and the voltage and specific gravity remain constant during the last three hours of charging. The checks should be made every hour.

If at the end of the charging the specific gravity of the electrolyte, with due temperature correction, differs from the recommended value, correct the specific gravity as follows. If the specific gravity is higher than necessary, remove

some electrolyte from the cells and add distilled water into the cells. If the specific gravity is lower than recommended, remove some electrolyte and add the electrolyte of higher specific gravity (1.4 g/cm^3) into the cells.

Having adjusted the specific gravity of electrolyte, continue to charge the battery for 30 min more to mix electrolyte. Then disconnect the battery and in 30 min determine the electrolyte level in all cells. If the level is below normal, add the electrolyte of the specific gravity prescribed for given climatic region (see Table 7-4). If the level is above normal, remove the surplus quantity using a rubber bulb.

ALTERNATOR

Specifications

Maximum output current at 13 V and 5000 min^{-1}, A 55
Regulated voltage range, V ..... 14.1±0.5
Maximum rotor speed, min^{-1} 13,000
Engine-to-alternator gear ratio 1:2.04

Design Peculiarities

The type 37.3701 alternator is a three-phase machine with a built-in rectifier unit and electronic voltage regulator. The alternator rotates clockwise (viewing the drive). To protect the alternator from dirt its rear end shield is covered with protective casing 4 (Fig. 7-11). However, various design versions of the casing and air intake may be employed.

Stator 21 (Fig. 7-3) and endshields 1 and 19 are clamped together by four through bolts. Rotor shaft 8 rotates in bearings 6 and 18 installed in the endshields. Power is supplied to the rotor winding (field winding) through the brushes and sliprings 5.

Three-phase alternating current induced in the stator winding is rectified in rectifier unit 2 secured to endshield 1. Electronic voltage regulator 12 made en-bloc with the brush holder is also secured to endshield 1.

The alternator connection diagram is depicted in Fig. 7-4. Alternator supply voltage, with the ignition turned on, is supplied to regulator terminal B through resistor 6 in the instrument cluster. After starting the engine, the field winding is supplied through three additional diodes installed in the rectifier unit. Control voltage is supplied to voltage regulator terminal Б directly from alternator terminal 30. Terminal Ш of the regulator has no marking. Brush 13 (Fig. 7-3) is connected with this terminal.

Voltage in the car electrical equipment system is controlled by electronic voltmeter 5 (Fig. 7-4) with a light-emitting diode (LED). When the voltage is within normal limits, the voltmeter light-emitting diode does not light. If the voltage is above tolerable value, the diode starts flickering, and if the voltage is below the tolerable limit, the LED lights constantly. When turning on the ignition, the LED lights up and after starting the engine, it should go off, if the alternator is in good repair.

Trouble Shooting

Cause	Remedy
Voltmeter Light-Emitting Diode Fails to Light Up When Ignition is Switched On	
1. Defective voltmeter	1. Replace voltmeter
2. Blown out fuse No. 2 in fuse unit	2. Replace fuse
3. Open-circuit fault in instrument cluster circuit:	
- no voltage supply from plug Б of fuse unit to instrument cluster;	- check wire О and its connections from fuse unit to instrument cluster;
- no voltage supply from ignition relay to plug Б of fuse unit;	- check wire ГЧ and its connections from fuse unit to ignition relay;
- open-circuit fault or poor contact in wire through which instrument cluster is connected to ground	- check wire Ч and its connections from instrument cluster to ground
4. Ignition switch or relay fails to operate:	
- defective contact part or ignition relay;	- check, replace defective contact part of ignition switch or relay;
- no voltage supply from switch to ignition relay;	- check wire Г and its connections between switch and ignition relay;
- open-circuit fault or poor contact in ignition relay grounding wire	- check wire Ч and its connections from ignition relay to ground
5. Defective voltage stabilizer to instrument cluster	5. Replace voltage stabilizer
Light-Emitting Diode (LED) is Alight with Engine Running. Discharged Storage Battery	
1. Slipping of alternator drive belt	1. Adjust belt tension
2. No contact between terminals B and Ш of voltage regulator and brush leads	2. Clean terminals B and Ш of voltage regulator and brush leads, bend regulator terminals

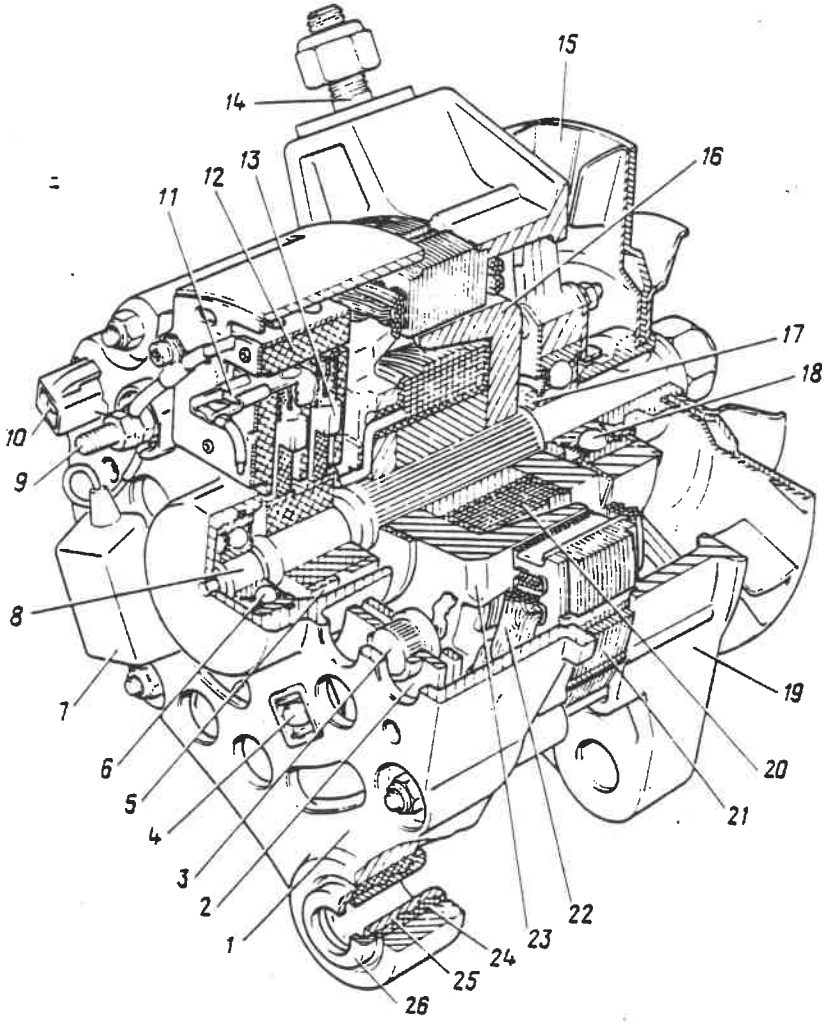

Fig. 7-3. Alternator 37.3701:
1 - slipring endshield; 2 - rectifier unit; 3 - rectifier of rectifier unit; 4 - rectifier unit attachment screw; 5 - slipring; 6 - rear ball bearing; 7 - capacitor; 8 - rotor shaft; 9 - alternator terminal 30; 10 - alternator terminal 61; 11 - voltage regulator terminal B; 12 - voltage regulator; 13 - brush; 14 - alternator-to-brace stud; 15 - pulley with fan; 16 - rotor pole piece; 17 - spacer bushing; 18 - front ball bearing; 19 - drive endshield; 20 - rotor winding; 21 - stator; 22 - stator winding; 23 - rotor pole piece; 24 - buffer bushing; 25 - bushing; 26 - hold-down bushing

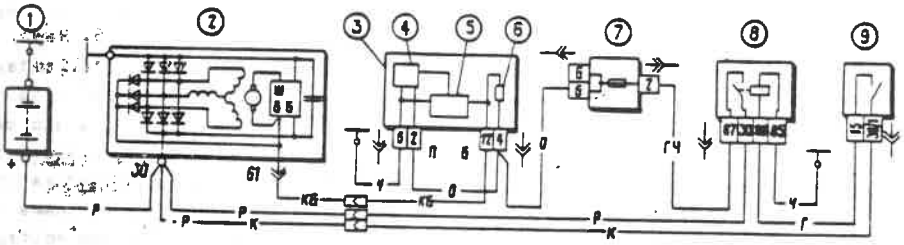

Fig.7-4. Alternator Connection Diagram:
1 - storage battery; 2 - alternator; 3 - instrument cluster; 4 - voltage stabilizer; 5 - voltmeter; 6 - resistor, 36 Ω, 5 W; 7 - fuse unit; 8 - ignition relay; 9 - ignition switch

Continued

Cause	Remedy
3. Open-circuit fault between instrument cluster and alternator terminal 61	3. Check wire 75 and its connections from alternator to instrument cluster
4. Wear or sticking of brushes, oxidation of sliprings	4. Replace brush holder with brushes, wipe sliprings with cloth wetted with gasoline
5. Defective voltage regulator	5. Replace voltage regulator
6. Defective rectifiers in rectifier unit	6. Replace rectifier unit
7. Defective field winding supply diodes	7. Replace diodes or rectifier unit
8. Field winding leads separated from slip-rings	8. Solder leads or replace alternator rotor
9. Open-circuit or short-circuit fault in stator winding, ground fault in stator winding	9. Replace alternator stator
Voltmeter Light-Emitting Diode (LED) Flickers When Engine is Running. Overcharged Storage Battery	
Defective voltage regulator (short-circuit fault between terminal III and ground)	Replace voltage regulator
Alternator Noisy	
1. Loose alternator pulley nut	1. Tighten up nut
2. Defective alternator bearings	2. Replace bearings
3. Turn-to-turn or ground fault in stator winding (alternator humming)	3. Replace stator
4. Short-circuit fault in one of alternator rectifiers	4. Replace rectifier unit
5. Squeaking of brushes	5. Wipe brushes and sliprings with cotton cloth wetted with gasoline

Caution:

The "minus" terminal of the storage battery should always be connected to "ground" and its "plus" terminal, to alternator terminal "30". An accidental wrong connection of the battery terminals will immediately cause an overcurrent through the alternator rectifiers, thus ruining them.

DO NOT operate the alternator when the storage battery is disconnected as this causes short-time overvoltages on alternator terminal 30 which might damage the alternator voltage regulator and electronic devices of the car circuit.

NEVER check the functioning of the alternator using "spark-jumping" method, i.e. by connecting alternator terminal "30" with "ground" even for a short time. This creates a very large current in the rectifiers and damages them. The alternator must be checked only with an ammeter and a voltmeter.

NEVER check the alternator rectifiers with voltage higher than 12 V or with a megohmmeter as voltage of this instrument is too high for the rectifiers and the latter will be punctured during the check (short circuit will take place).

NEVER check the car circuits with a megohmmeter or a lamp supplied with voltage higher than 12 V. If such a check is required, first disconnect the wires from the alternator.

The stator insulation resistance should be checked by a high voltage only on a test stand having first disconnected the phase windings from the rectifiers.

If some welding work is to be performed on the car body, disconnect the wires from all the alternator and battery terminals.

Check Tests

Stand Test

The stand test is intended to check the condition of the alternator and to make sure whether its characteristics comply with the requirements. The brushes of the alternator under checking should be well bedded to the alternator sliprings and the sliprings should be clean.

Mount the alternator on the stand and make connections as shown in Fig. 7-5. Start the stand motor, adjust alternator output voltage to 13 V by rheostat 4 and accelerate the rotor to 5000 min^{-1}. Work the alternator at this speed for at least 10 minutes and then measure the output current. In a serviceable alternator it should be not under 55 A.

If the output current is smaller, this can be caused by some fault in the stator or rotor windings or by damaged rectifiers. In this case the windings and rectifiers should be thoroughly checked to identify the fault.

The alternator output voltage is checked at a rotor speed of 5000 min^{-1}. Using rheostat 4 set the output current of 15 A and measure the output voltage which should be (14.1±0.5) V at the ambient and alternator temperature of (25±10)°C.

If the voltage value comes out of the specified limits, replace the voltage regulator with new one which is positive, sound and repeat the test. If the voltage now is normal, it means that the old regulator is defective and should be replaced. If the voltage still comes out of the specified limits, check the alternator windings and its rectifiers.

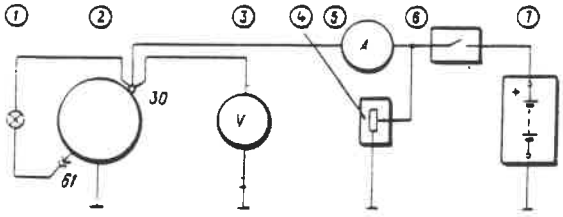

Fig.7-5. Alternator Test Stand Hookup:
1 - test lamp, 12 V, 3 W; 2 - alternator;
3 - voltmeter; 4 - rheostat; 5 - ammeter; 6 - switch;
7 - storage battery

Checking Alternator by Electronic Oscilloscope

The oscilloscope makes it possible to accurately and quickly check the condition of the alternator and determine the nature of the trouble by the shape of the rectified voltage curve.

To perform the checking hook up the circuit shown in Fig. 7-6. Disconnect the common terminal wire of three additional diodes from plug B of the voltage regulator and take measures to preclude the tip of the disconnected wire from contact with the alternator frame. Connect the wire from the storage battery to regulator plug B through test lamp 1. Now the field winding will be supplied only from the storage battery.

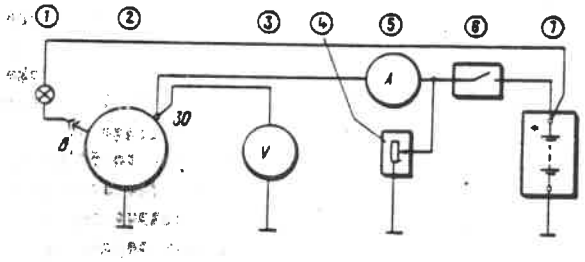

Fig.7-6. Test Hookup for Checking Alternator by Oscilloscope:
1 - test lamp, 12 V, 3 W; 2 - alternator;
3 - voltmeter; 4 - rheostat; 5 - ammeter;
6 - switch; 7 - storage battery

Switch on the stand motor and raise the rotor speed to 1500-2000 min^{-1}. Disconnect the storage battery from alternator terminal 30 by switch 6 and set the output current to 10 A by rheostat 4.

Check the voltage across alternator terminal 30 by the oscilloscope. If the rectifiers and stator windings are in good condition, the rectified voltage curve will be of saw-like pattern with uniform teeth (Fig. 7-7, I). If there is an open-circuit fault in the stator winding or an open-circuit or short-circuit fault in the rectifiers of the rectifier unit, the shape of the curve will be radically changed: the teeth will be non-uniform and deep valleys will appear (Fig. 7-7, II and III).

Having checked the shape of voltage curve on the alternator terminal 30 and having made sure that the shape of the curve is normal, check the voltage across plug 61 or on the tip of the wire disconnected from plug B of the voltage regulator. These points are common terminal of three additional diodes (Fig. 7-4) through which the field winding is supplied during the operation of the alternator. The shape of the voltage curve should also be of correct saw-like pattern. The curve with non-uniform teeth indicates defects in the additional diodes.

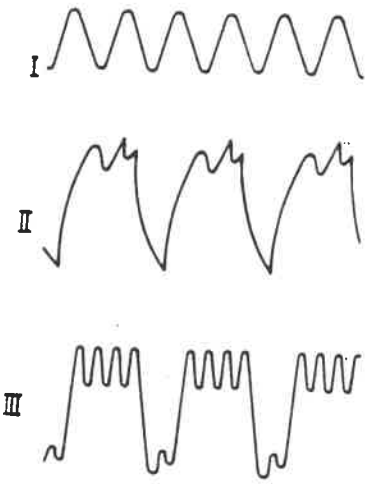

Fig.7-7. Alternator Rectified Voltage Curves:
I - alternator in good repair; II - breakdown of rectifier; III - open circuit fault in rectifier circuit (stator winding)

Rotor Field Winding Test

To check the field winding it is not necessary to remove the alternator from the car. For the check it is sufficient to remove the protective casing and the voltage regulator with the brush holder. If necessary, clean the sliprings with a glass cloth and then using an ohmmeter or a test lamp check the winding for open-circuit or ground fault.

Stator Test

The stator should be tested separately after disassembling the alternator and disconnecting the stator winding leads from the rectifiers.

The first thing to do is to check the stator winding for open circuits and ground faults with an ohmmeter or a test lamp and a storage battery.

The insulation of the winding wires should bear no signs of overheating caused by a short circuit in the rectifiers. Replace the stator if its winding is damaged in this manner.

Finally, check the stator winding for short-circuited turns with a growler.

Rectifiers Test

A sound rectifier passes current in one direction only. A faulty one may either pass no current at all (open circuit) or pass it in both directions (short circuit).

If one of the rectifiers is damaged, the entire rectifier unit has to be replaced.

The rectifiers can be checked for shorts without removing the alternator from the car, having first disconnected the wires from the storage battery and alternator and removed the shield. Disconnect regulator terminal B from alternator terminal 30 and the wire from voltage regulator terminal B. Checking may be done with an ohmmeter or a test lamp (1-5 W, 12 V) and a storage battery as shown in Fig. 7-8.

Note. To simplify the fastening of the rectifier parts, three rectifiers (marked red) form rectified voltage "plus" on the body. These rectifiers are "positive" and they are pressed into one plate of the rectifier unit connected with alternator terminal 30. Three other rectifiers ("negative" ones, marked black) form rectified voltage "minus" on the body. They are pressed into the other plate of the rectifier unit connected to the ground.

Begin with checking for simultaneous shorts in the positive and negative rectifiers. For this purpose connect the plus terminal of the battery through a test lamp to alternator terminal 30, and the minus terminal, to the alternator frame (Fig. 7-8.I). If the lamp lights, there is a short-circuit fault in the negative and positive rectifiers.

The negative rectifiers can be checked for short circuit by connecting the battery plus terminal through the test lamp with one of the rectifier unit attachment bolts, and the minus terminal of the battery, with the alternator frame (Fig. 7-8, II). Burning of the lamp will indicate a short circuit fault in one or several negative rectifiers. Bear in mind that the lamp will light also if the stator winding turns are shorted to the alternator frame. But such a trouble is a rear occasion and in the majority of cases the fault lies with the rectifiers.

To check the positive rectifiers for short circuit fault connect the battery plus terminal through the lamp with alternator terminal 30 and the minus terminal with one of the rectifier unit attachment bolts (Fig. 7-8, III). Lighting of the lamp will indicate a short-circuit fault in one or several positive rectifiers.

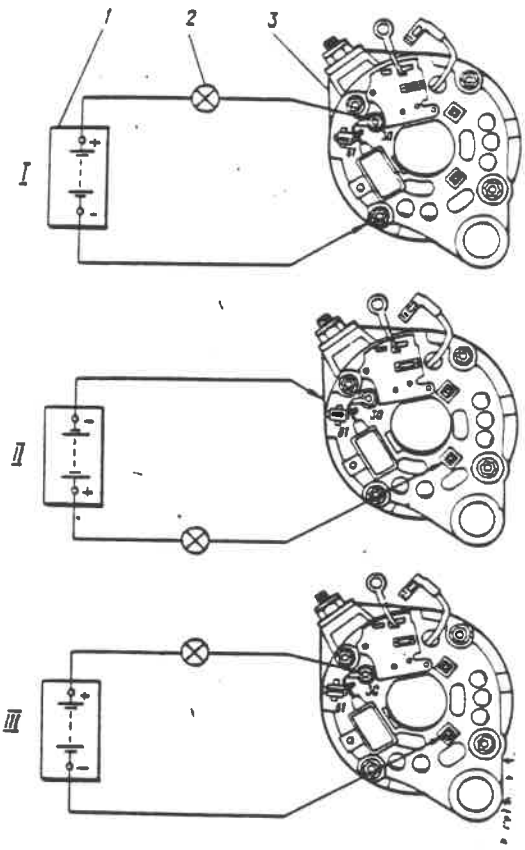

Fig.7-8. Hookup for Checking Rectifier Unit Rectifiers:
1 - storage battery; 2 - test lamp; 3 - alternator; I - checking simultaneously 'positive' and 'negative' rectifiers; II - checking 'negative' rectifiers; III - checking 'positive' rectifiers

The open-circuit fault in the rectifiers can be revealed without disassembling the alternator either using an oscilloscope or by checking the alternator on a stand by considerable drop (by 20-30%) of output current value as compared with the rated value. If the windings, additional diodes and voltage regulator of the alternator are in good repair and there is no short-circuit fault in the rectifiers, the cause of drop of output current is open-circuit fault in the rectifiers.

Additional Diodes Check

A short circuit fault in the additional diodes can be revealed without removing and disassembling the alternator using the circuit shown in Fig. 7-9. As in case of checking the rectifiers of the rectifier unit, disconnect the wires from the storage battery and the alternator, remove the alternator protective casing and disconnect the wire from voltage regulator terminal B.

Connect the plus terminal of the battery through a lamp (1-3 W, 12 V) to alternator termi-

nal 61 and the minus terminal to one of the rectifier unit attachment bolts.

If the lamp lights, one of the additional diodes is at fault. To find the faulty diode remove the rectifier unit and check each diode in turn.

An open-circuit fault in the additional diodes can be revealed by means of an oscilloscope by change of voltage curve pattern when checking the voltage across plug 61 and by low voltage (less than 14 V) across plug 61 at a medium speed of the alternator rotor.

Voltage Regulator Check

The voltage regulator serves to continuously and automatically change the alternator field current value to maintain the alternator voltage within the preset limits at speed and load variations.

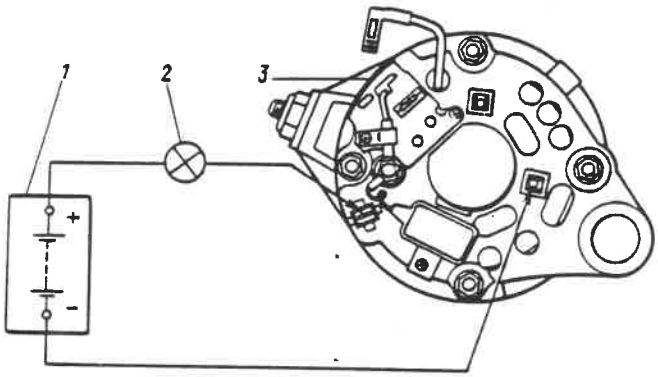

Fig.7-9. Additional Diodes Test Circuit Diagram: 1 - storage battery; 2 - test lamp; 3 - alternator

Checking on car. To check the regulator a DC voltmeter, scale range 15-30 V, accuracy class not below 1.0 is required.

Let the engine operate for 15 min at a medium speed with the headlights switched on and then measure the voltage between terminal 30 and the alternator frame. The voltage should be within 13.6 and 14.6 V.

In this case, if the battery is systematically undercharged or overcharged and the regulated voltage comes out of the specified limits, replace the voltage regulator.

Checking of voltage regulator removed from car. The voltage regulator removed from the alternator should be checked using the circuit shown in Fig. 7-10. The voltage regulator should be preferably checked together with the brush holder as this check will reveal simultaneously torn off brush leads and poor contact between the voltage regulator and brush holder terminals.

Connect a test lamp of 1-3 W, 12 V between the brushes. Connect a supply source of 12 V, and then of 15-16 V, to terminals Б and В and to the regulator frame.

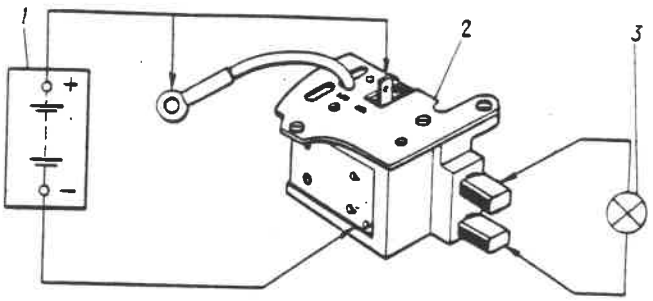

Fig.7-10. Voltage Regulator Test Circuit Diagram: 1 - storage battery; 2 - voltage regulator; 3 - test lamp

If the regulator is in good repair, the lamp will light in the first case and will go out in the second case.

If the lamp lights in both cases, the voltage regulator is punctured and if the lamp does not light in both cases, either there is an open-circuit fault in the regulator or there is no contact between the brushes and the voltage regulator terminals.

Capacitor Checks

The capacitor serves to protect the car electronic equipment against voltage surges in the ignition system and to reduce radio noises.

Damage of the capacitor or its loose attachment on the alternator (poor contact with the frame) is manifested by heavy radio noises with the engine operating.

The condition of the capacitor may be checked with a megohmmeter or a tester (scale 1-10 MΩ). If there is no open-circuit fault in the capacitor, the pointer of the instrument will deflect in the direction of resistance drop and then slowly return to the initial position when the probes of the instrument are touched to the capacitor terminals.

The capacitance of the capacitor measured with a special instrument should be 2.2 μF±20%.

Alternator Repairs

Disassembly of Alternator

Loosen the clamp and disconnect air intake (Fig. 7-11) from the connection of protective casing 4. Turn out two screws 1 and nuts from contact bolt extension 5 and remove protective casing 4. Disconnect wire 6 from alternator terminal 61 and turn out contact belt extension 5.

Disconnect the wire from voltage regulator plug B. Disconnect the regulator and capacitor wires from alternator terminal 30 and turn out the voltage regulator attachment screws.

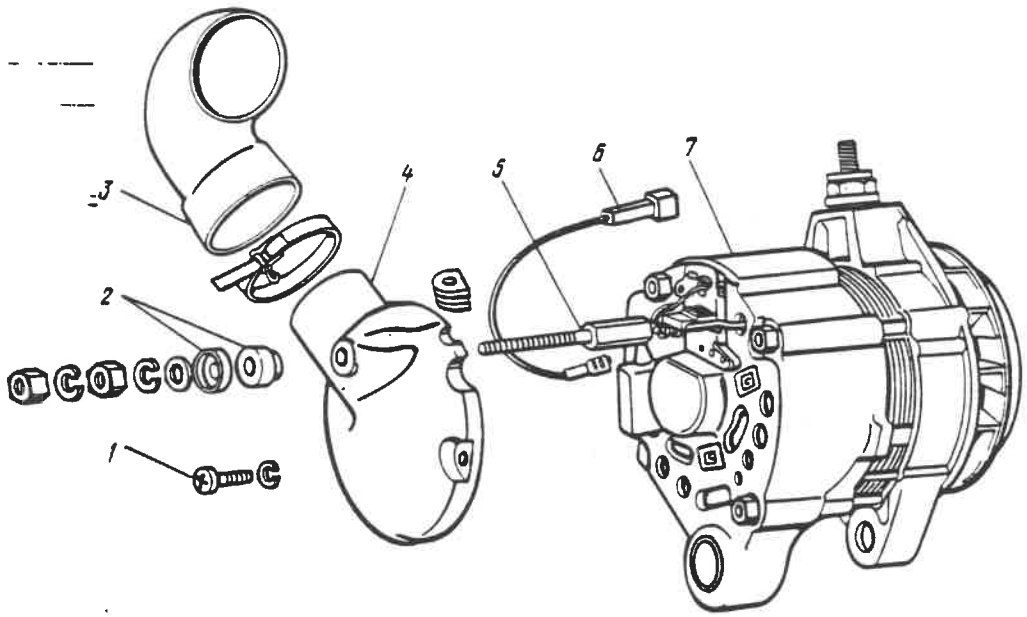

Fig.7-11. Removing Protective Casing from Alternator:
1 - casing attachment screw; 2 - insulating bushings; 3 - air intake; 4 - protective casing; 5 - extension of alternator terminal 30; 6 - wire of alternator terminal 61; 7 - alternator

Not to break the brushes when removing the brush holder, insert the blade of a screwdriver between the body of voltage regulator 1 (Fig. 7-12) and brush holder 2 and pull out the regulator partially, leaving the brush holder in place. Then tilt and take out the regulator complete with the brush holder from the alternator. Turn out the attachment screw and remove capacitor 20.

Turn off the nuts of through bolts 14 and remove alternator endshield 11 complete with the rotor and pulley.

Clamp the rotor in a vice, turn off the pulley nut and using puller 02.7823.9504 remove the pulley from the rotor shaft. Take a Woodruff key from the slot on the shaft and remove endshield 11.

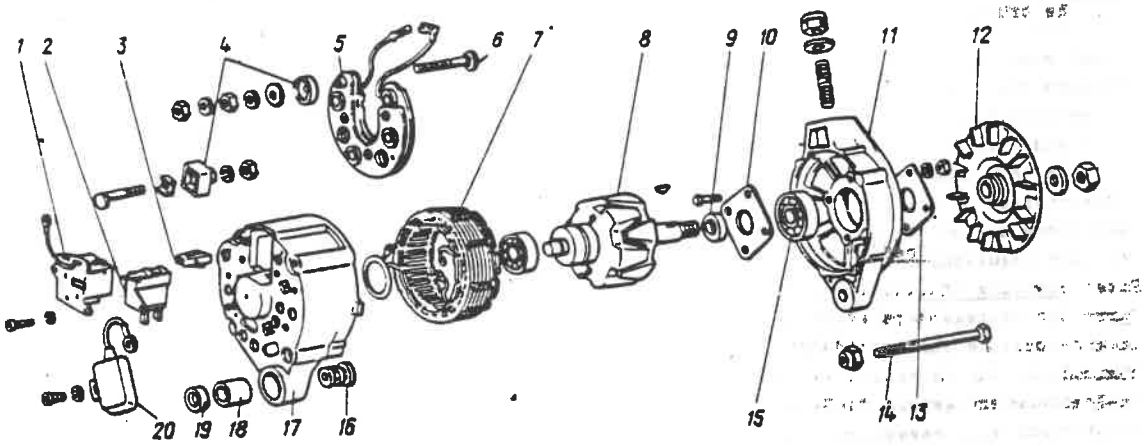

Fig.7-12. Alternator Parts:
1 - voltage regulator; 2 - brush holder; 3 - additional diodes terminal connector socket; 4 - insulating bushings; 5 - rectifier unit; 6 - contact bolt; 7 - stator; 8 - rotor; 9 - spacer bushing; 10 - bearing inner attachment washer; 11 - drive endshield; 12 - pulley; 13 - bearing outer attachment washer; 14 - through bolt; 15 - rotor front ball bearing; 16 - bushing; 17 - slipring endshield; 18 - buffer bushing; 19 - hold-down bushing; 20 - capacitor

Turn off the nuts of the screws connecting the rectifier tips with the stator winding leads and take stator 7 out of alternator endshield 17.

Turn off the nut of contact bolt 6, disconnect the plug of the additional diodes wire from connector 3 and remove rectifier unit 5.

Assembly of Alternator

To assemble the alternator reverse the disassembly operations.

To prevent damage to the brushes, prior to installing the regulator with the brush holder in place, partially shift the brush holder into the voltage regulator (do not move it in place completely) and install into the alternator in this state. Having installed the brush holder in place in the alternator endshield, lightly press on the voltage regulator to fit it in place in the alternator.

Axial misalignment of the holes in the alternator endshield feet should not exceed 0.4 mm. So when assembling, install a special gauge into the holes.

A conical spring washer of the pulley should touch the nut with its convex side. Tighten the pulley nut to a torque of 38.4-88 N.m (3.9-9.0 kgf.m).

Replacement of Brush Holder

If the brushes are worn down and project by less than 5 mm from the brush holder, replace the brush holder complete with the brushes. To replace move the brush holder out of the regulator body by pressing on terminal B. Remove and install the voltage regulator as laid in Chapters above: Disassembly and Assembly of Alternator, not to cause damage to the brushes.

Prior to installing a new voltage regulator with the brush holder in place, blow out the seat in the alternator to remove carbon dust and wipe off oil mixed with carbon dust.

Replacement of Rotor Bearings

To remove a faulty bearing from the drive endshield, turn off the nuts of the screws holding the bearing attachment washers, remove the washers with the screws and press out the bearing using a hand-operated press. If the screw nuts fail to turn off (the ends of the screws are staked), file off the ends of the screws.

Install a new bearing into the alternator endshield only if the bore for the bearing in the endshield is of true shape and its diameter does not exceed 42 mm, otherwise the endshield should be replaced by a new one.

The bearing should be press-fitted in the endshield on a press and then clamped between two washers tightened by screws with nuts. Having tightened the nuts, stake the ends of the screws.

If the bearing at the slipring side is to be replaced, replace simultaneously the endshield as if the bearing is damaged, the bore in the endshield is damaged too. The bearing is removed from the rotor by a puller and is press-fitted on a press.

Replacement of Additional Diodes

To replace a faulty diode unsolder its leads and carefully take the diode out of the plastic holder without applying sharp strokes to the rectifier unit. Then clean the diode mounting place from remnants of epoxy resin, install a new diode and solder it up.

Solder the diode lead with a colour mark to the rectifier terminals. After soldering glue the diode body to the holder with epoxy resin.

STARTER

Specifications

Rated power, kW 1.3
Current consumed at rated power, A ..... 290±10
Locked-torque current consumption, maximum, A 550
No-load current consumption, maximum, A .. 60

Design Peculiarities

The type 35.3708 starter is a DC compound-wound motor with a two-winding solenoid switch.

Frame 17 (Fig. 7-13) of the starter accommodates four poles 18 with field windings of which three windings are series ones and one winding is shunt one. The frame with end heads 6 and 15 are clamped together by two bolts. The armature has an endface commutator The shaft of the armature rotates in cermet bushings 14 press-fitted in end heads 6 and 15.

The starter connection diagram is depicted in Fig. 7-14. With the starter switched on, voltage from the storage battery is supplied through type 113.3747-10 auxiliary relay 4 to the windings of the starter solenoid switch (pull-in winding II and hold-on winding I). When the contacts of the solenoid switch close, the pull-in winding gets disconnected.

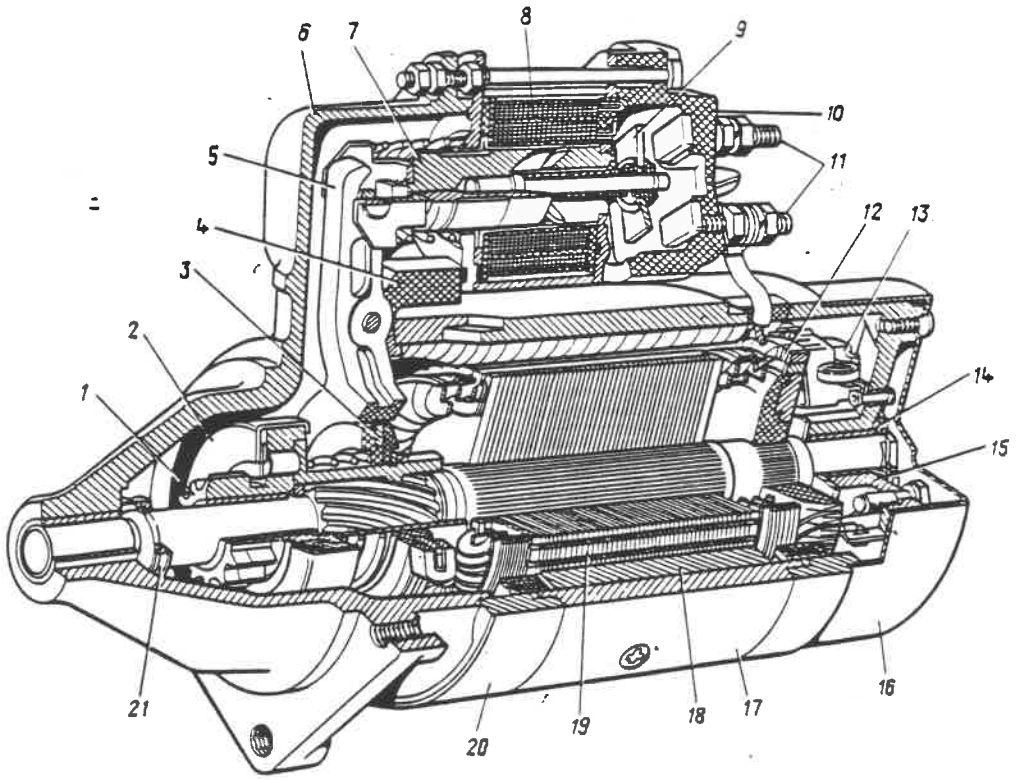

Fig.7-13. Starter 35.3708:
1 - drive pinion; 2 - overrunning clutch; 3 - carrier ring; 4 - rubber plug; 5 - shift lever; 6 - drive end head; 7 - solenoid switch armature; 8 - solenoid switch winding; 9 - contact plate; 10 - solenoid switch cover; 11 - contact bolts; 12 - commutator; 13 - brush; 14 - armature shaft bushing; 15 - commutator end head; 16 - cover casing; 17 - frame; 18 - stator pole; 19 - armature; 20 - spacer ring; 21 - limiting ring

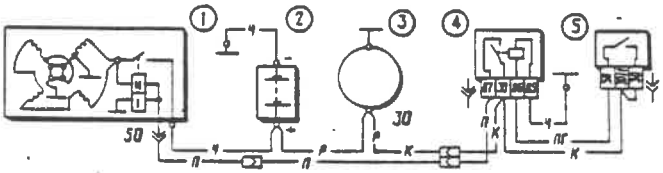

Fig.7-14. Starter Connection Diagram:
1 - starter; 2 - storage battery; 3 - alternator; 4 - starter auxiliary relay; 5 - ignition switch

Trouble Shooting

Cause	Remedy
With Starter Switched On, Armatures Fails to Rotate, Solenoid Switch Does Not Operate	
1. Defective or completely discharged storage battery	1. Charge or replace storage battery
2. Battery terminals or wire clamps are badly oxidized; loose wire clamps	2. Clean battery terminals and wire clamps, tighten wire clamps and coat them with petroleum jelly
3. Turn-to-turn fault in pull-in winding of solenoid switch, ground fault or open-circuit fault of winding	3. Replace solenoid switch
4. Defective starter cut-in relay	4. Clean relay contacts. Replace defective relay
5. Open-circuit fault in supply circuit of starter cut-in relay winding	5. Check wires and their connections in circuit between ignition switch plug 50 and relay plug 86
6. Contacts 30 and 50 of ignition switch fail to close	6. Replace contact part of ignition switch
7. Open-circuit fault in starter solenoid switch supply wires	7. Check wires and their connection in circuit: storage battery - starter cut-in relay - plug 50 of solenoid switch
8. Jamming of solenoid switch armature	8. Remove solenoid switch, check armature for ease of travel

Continued

Continued

Cause	Remedy
With Starter Switched On Its Armature Fails to Rotate or Rotates Sluggishly, Solenoid Switch Operates	
1. Defective or discharged storage battery	1. Charge or replace battery
2. Battery terminals or wire clamps are oxidized; loose wire clamps	2. Clean battery terminals and wire clamps; tighten wire clamps and coat them with petroleum jelly
3. Loose tips of wire connecting engine unit with body	3. Tighten attachment of wire tips
4. Oxidized contact bolts of solenoid switch or loose nuts holding wire tips on contact bolts	4. Clean contact bolts, tighten wire attachment nuts
5. Burning of commutator, sticking of brushes or their wear	5. Clean commutator, replace brushes
6. Open-circuit or short-circuit fault in stator or armature windings	6. Replace stator or armature
7. Ground fault in plus brush holder	7. Eliminate trouble or replace commutator end head
With Starter Switched on Its Solenoid Switch 'Pumps'	
1. Discharged storage battery	1. Charge battery
2. Open-circuit or short-circuit fault in solenoid switch hold-on winding	2. Replace solenoid switch
3. Heavy voltage drop in solenoid switch supply circuit caused by oxidation of wire tips	3. Check wires and their connections in circuit from storage battery to solenoid switch plug 50
With Starter Switched on, Its Armature Rotates, but Flywheel Stands Still	
1. Overrunning clutch slipping	1. Check starter on stand, replace clutch
2. Clutch shift lever broken or its shaft has slipped out	2. Replace lever or put in place its shaft
3. Breaking of clutch retainer ring or buffer spring	3. Replace clutch

Continued

Cause	Remedy
Abnormal Noise of Starter During Armature Rotation	
1. Excessive wear of bearing bushes or armature shaft journals	1. Replace starter
2. Starter fastenings loose or drive end head broken	2. Tighten nuts or repair starter
3. Starter fastened out of true	3. Check starter mounting
4. Loosening of stator pole (armature rubs pole)	4. Tighten pole screw
5. Damaged teeth of starter pinion or flywheel ring gear	5. Replace starter pinion or flywheel
6. Pinion fails to disengage from flywheel:	
- jamming of shift lever	- replace lever
- clutch seized on armature shaft splines	- clean splines and coat them with engine oil
- clutch or solenoid switch springs weak or broken	- replace clutch or solenoid switch
- lock ring has come off clutch hub	- replace faulty parts
- solenoid switch armature seized	- replace solenoid switch or eliminate seizure
- faulty ignition switch contact unit: contacts 30 and 50 fail to open	- check for correct contacting in various positions of ignition key; replace faulty contact unit

Stand Tests

If there is any doubt as to the efficiency of the starter, check the starter on a stand.

A hookup for checking the starter on the stand is shown in Fig. 7-15. The cross-section of the wires leading to the power source, ammeter and to the contact bolt of the starter solenoid switch should be not less than 16 mm^2.

The temperature during the tests should be $(25\pm5)^{\circ}C$ and the brushes must be well seated on the commutator.

Performance Test

Closing switch 5 (Fig. 7-15) and using a 12 V power source, apply the starter three times with different brake torques, e.g. 2, 6, 10 N·m (0.2, 0.6, 1 kgf·m). Each time the starter should

be applied for not longer than 5 s with intervals between successive applications at least 5 s.

If the starter fails to rotate the stand ring gear or is noisy in operation, disassemble it and examine its parts.

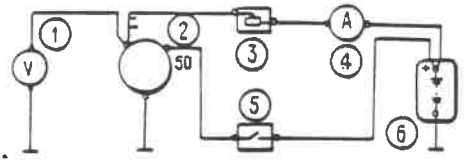

Fig.7-15. Starter Test Stand Hookup:
1 - voltmeter, scale not under 15 V; 2 - starter; 3 - rheostat, 800 A; 4 - ammeter with 1000 A shunt; 5 - switch; 6 - storage battery

Locked-Torque Test

Lock the stand ring gear, switch on the starter and measure the current, voltage and torque which should not be over 550 A and 7.5 V, and not under 13.7 N.m (1.4 kgf.m), respectively. Apply the starter for not longer than 5 s.

If the torque is lower and the current is higher than the above-specified values, this may be probably caused by shorted turns or ground fault of the stator and armature windings.

If the brake torque and current drain are lower than specified above, the cause may be oxidation and soiling of the commutator, heavy wear of the brushes or weakening of their springs, jamming of the brushes in the holders, loose attachments of the stator winding leads, oxidation or burning of the solenoid switch contact bolts.

With the pinion locked, the starter armature should not rotate. If it does, the overrunning clutch is faulty.

To remedy the defects, disassemble the starter and replace or repair damaged parts.

No-load Test

Disengage the ring gear of the stand from the starter pinion. Switch on the starter and measure the current drain and the armature speed which should be not over 60 A and (5000±1000) min^{-1}, at 11.5-12 V across the starter terminals.

If the current drain and the armature speed differ from the above-indicated values, the causes may be the same as those in the previous test.

Solenoid Switch Test

Place a gasket 12.8 mm thick between limiting ring 21 (see Fig. 7-13) and the pinion and energize the solenoid switch. Cut-in voltage of the solenoid switch when the pinion thrusts against the gasket should not exceed 9 V at an ambient temperature of (25±5)°C. If the voltage exceeds the indicated value, either the solenoid switch or its drive is defective.

Starter cut-in relay. Cut-in voltage of the relay should not exceed 8 V at a temperature of (23±5)°C. If the voltage exceeds the indicated value, either the relay or drive is at fault.

Repairs

Disassembly

Turn off the nut on the lower contact bolt of solenoid switch 4 (Fig. 7-16) and disconnect the stator winding lead from the switch. Turn off the nuts of the solenoid switch and remove the latter. Take the stopper out of the front end head.

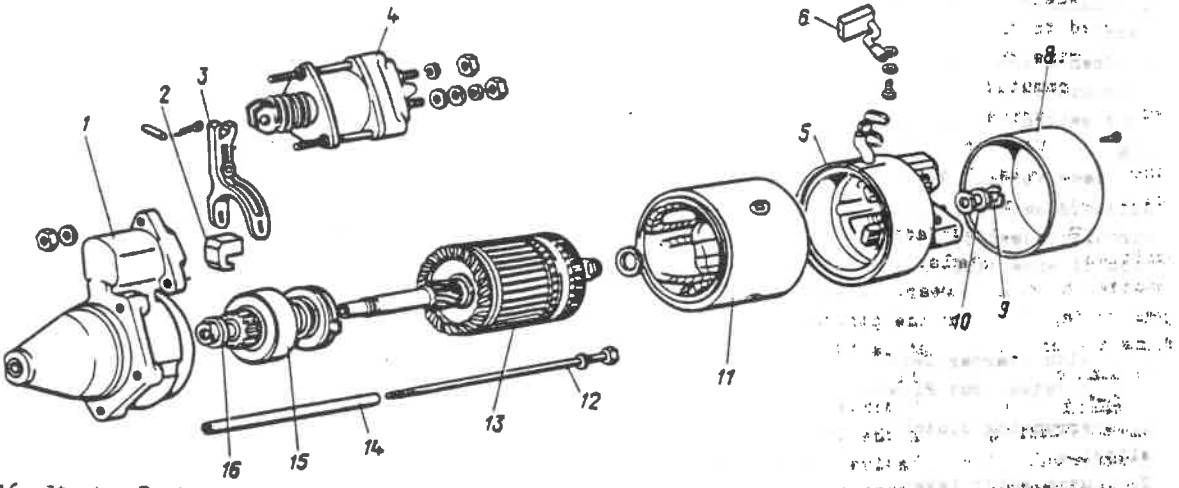

Fig.7-16. Starter Parts:
1 - starter drive end head with spacer ring; 2 - rubber plug; 3 - shift lever; 4 - starter solenoid switch; 5 - commutator end head; 6 - brush; 7 - brush spring; 8 - cover casing; 9 - retaining ring; 10 - adjusting washer; 11 - frame; 12 - through bolt; 13 - armature; 14 - insulating tube; 15 - overrunning clutch with drive pinion; 16 - limiting ring

Turn out the screws and remove cover casing 8. Remove retaining ring 9, turn out through bolts 12 and disconnect frame 11 with end head 5 from end head 1 with armature 13.

Turn out the screws holding the stator winding leads to the brush holders and disconnect the frame from the commutator end head. Remove springs 7 and brushes 6.

Uncotter and take the shift lever and armature with the drive out of the end head and then disconnect the lever from the drive.

To remove the drive from the armature, take the retaining ring from under limiting ring 16. The drive should be disassembled after removing the lockwasher from the hub of the overrunning clutch.

To disassemble the solenoid switch turn off the nuts of the clamping bolts and unsolder the winding leads from plug 50 and from the end piece secured on the lower contact bolt of the solenoid switch.

After disassembly blow the parts with compressed air and wipe them.

Inspection and Repairs

Armature. Using a megohmmeter or a 220 V test lamp check the armature winding for ground faults.

The voltage is fed through the lamp to the commutator bars and the armature core. If the lamp is alight it means that either the armature winding or the commutator bars are shorted to the ground. When a megohmmeter is used, it should read a resistance of not less than 10 kΩ . The armature with a ground fault should be replaced.

Using a special tester, check for short circuits between the armature winding sections or commutator bars and for open circuits at the points where the ends of the winding sections are soldered to the commutator bars.

Examine the working surface of the commutator. If the commutator is soiled or burnt, dress it with fine abrasive cloth.

Check the core for runout relative to the shaft journals. Replace the armature if the runout exceeds 0.08 mm.

Examine the surfaces of the armature shaft splines and journals. They should be free of scores, nicks and wear. If the shaft surface bears yellow deposit from the pinion bush, remove it with fine abrasive cloth since it may cause jamming of the pinion on the shaft.

Drive. The starter drive should move freely, without binding, along the armature shaft. The pinion should turn relative to the armature shaft in the direction of rotation of the armature under the action of a torque not exceeding 0.27 N.m (2.8 kgf.cm). The pinion must not turn in the opposite direction. If nicks are detected on the engagement portion of the teeth, sand-paper them with a grinding stone of small diameter.

If the parts of the starter drive are damaged or considerably worn, replace the drive by a new one.

Stator. Using a megohmmeter or a 220 V test lamp, check the stator winding for ground faults. The voltage is fed through the lamp to the common terminal of the winding and to the starter frame. If the lamp lights or the megohmmeter reading is under 10 kΩ , also if the windings show signs of overheating (darkened insulation), replace the frame with the windings.

End heads. Examine the end heads for cracks. Replace them, if cracked. Inspect the end head bushes. If they are worn, replace either the end head assemblies or the bushes alone. After press-fitting, ream out the new bushes to a diameter of $12.015^{+0.03}$ mm.

Check to see that the brush holders are reliably secured in the commutator end head. The positive brush holders should have no ground faults. The brushes must be free to move in their holders. The brushes worn down to a length of 12 mm should be replaced by new ones and carefully bedded to the commutator.

Using a dynamometer, check the brush spring pressure; for new brushes it should be 9.8 ± 0.98 N (1 ± 0.1 kgf). If necessary, replace the springs by new ones.

Solenoid switch. Check the switch armature for freedom of movement. Using an ohmmeter, check the contact bolts for reliable contact with the contact plate. If the contact is poor, disassemble the switch and dress the contact bolts with fine abrasive cloth or a flat barette file. If the contact bolts are seriously damaged at the point where they touch upon the contact plate, turn them through 180°.

Assembly

Assembly of the starter is the reverse of its disassembly.

Before assembling the starter, coat the helical splines of the armature shaft and overrunning clutch hub pinion and end head bushes with engine oil. Coat the carrier ring of the drive with ЛИТОЛ-24 grease.

Put an insulating plastic tube onto the through bolt passing under the bus of the stator series coils.

By selecting the thickness of adjusting washer 10 (Fig. 7-16) provide axial free travel of the armature not exceeding 0.5 mm. After assembly check the starter on a stand.

Design Peculiarities

The ignition system used in the car is of fully transistorized type. It consists of ignition pickup-distributor 5 (Fig. 7-17), transistor switch 3, ignition coil 4, spark plugs 6, switch 1 with type 113.3747-10 ignition relay 2 and high-tension wires. The supply circuit of the ignition coil primary winding is interrupted by the transistor switch. Control pulses are supplied to the transistor switch from the non-contact pickup arranged in the ignition pickup-distributor 5.

Ignition pickup-distributor, type 3810.3706, is four-spark, non-shielded, with vacuum and centrifugal spark timers with built-in microelectronic control pulse pickup.

Transistor switch, type 3620.3734 or HIM-52 or BAT10.2, converts the control pulses of the pickup into the current pulses in the ignition coil primary winding.

Ignition coil, type 27.3705 or 27.3705-01 with an open-circuit magnetic circuit, oil-filled, sealed.

Spark plugs, type PE65PR, PE65CPR or A17IBP with resistors-suppressors.

Ignition switch, type 2101-3704000-11 with an antitheft device.

Trouble Shooting

Continued

Cause	Remedy
Engine Fails to Start	
1. No voltage pulses from pickup are delivered to transistor switch:	
- open-circuit fault in wire between ignition pickup-distributor and transistor switch;	- check wires and their connections; replace damaged wires;
- defective non-contact pickup	- check pickup by means of adapter connector and voltmeter; replace defective pickup
2. No current pulses are supplied to ignition coil primary winding:	
- open-circuit fault in wires connecting transistor switch with ignition switch or coil	- check wires and their connections; replace defective wires;
- defective transistor switch;	- check transistor switch with oscilloscope; replace defective transistor switch
- ignition switch or relay fails to operate	- check, replace contact part of ignition switch or relay
3. No high voltage is supplied to spark plugs:	
- H.T. wires are loose in sockets, their tips are torn off or oxidized, wires are heavily soiled or their insulation is damaged;	- check and restore connections, clean or replace wires;
- worn or defective contact carbon brush; sticking of carbon brush in pickup-distributor cap;	- check and, if necessary, replace carbon brush;
- current leaks through cracks or burns-through in cap or rotor of ignition pickup-distributor, through carbon layer or moisture on inner surface of cap;	- check cap, clean it from moisture and carbon, replace cap and rotor if cracked;
- burned out resistor in ignition pickup-distributor rotor;	- replace resistor;
- defective ignition coil	- replace ignition coil
4. Spark plug electrodes smeared with oil, incorrect spark plug gap	4. Clean spark plugs and adjust spark plug gap
5. Defective spark plugs (insulator cracked)	5. Replace spark plugs with new ones
6. Incorrect order of connection of H.T. wires to terminals of pickup-distributor cap	6. Connect wires in firing order: 1-3-4-2
7. Incorrect ignition timing	7. Check and adjust ignition timing
Engine Runs Unsteadily or Stalls at Idling	
1. Early ignition	1. Check and adjust ignition timing
2. Too large spark plug gap	2. Check and adjust spark plug gap
Engine Runs Unsteadily at High Speed	
Weak springs of flyweights in centrifugal timer of pickup-distributor	Replace springs, check operation of centrifugal timer on stand
Engine Misses at All Speeds	
1. Defective wires in ignition system, loose attachment of wires, oxidized wire tips	1. Check wires and their connections. Replace damaged wires
2. Wear of electrodes or oiling of spark plugs; heavy carbon layer, cracked insulator	2. Check spark plugs, adjust spark plug gaps, replace defective spark plugs

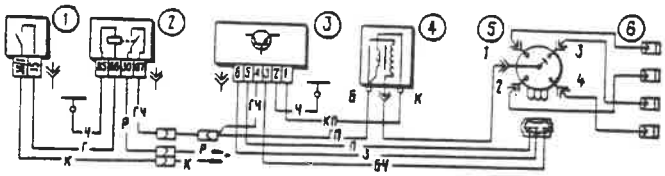

Fig.7-17. Ignition System Circuit Diagram:
1 - ignition switch; 2 - ignition relay; 3 - transistor switch; 4 - ignition coil; 5 - ignition pickup-distributor; 6 - spark plugs

Continued

Cause	Remedy
3. Worn out or damaged carbon brush in pickup-distributor cap	3. Replace carbon brush
4. Badly burnt central contact of pickup-distributor rotor	4. Clean central contact
5. Cracks, contaminants or burns-through in rotor or cap of pickup-distributor	5. Check, replace rotor or cap
6. Defective transistor switch - waveforms of pulses on primary winding of ignition coil differ from normal	6. Check transistor switch using oscilloscope, replace defective transistor switch
Engine Lacks Power and Pickup	
1. Incorrect ignition timing	1. Check and adjust ignition timing
2. Binding of flyweights in centrifugal timer, weak flyweight springs	2. Check, replace defective parts
3. Defective transistor switch - waveforms of pulses in primary winding of ignition coil differ from normal	3. Check transistor switch using oscilloscope, replace defective transistor switch

Caution:

The car is furnished with a high-energy ignition system employing many electronic devices. So, to prevent injuries and not to cause damage to the electronic units strictly observe the following requirements.

With the engine running, DO NOT touch the ignition system elements (transistor switch, ignition coils, H.T. wires).

DO NOT try to start the engine by means of a spark gap, NOR check the ignition system by spark-jumping method (between the H.T. wire tip and the frame).

DO NOT lay the L.T. wires in one bundle with the H.T. wires.

WATCH FOR reliable contact of the transistor switch with the frame through the attachment screws. Poor contact affects reliability of operation.

With the ignition on, DO NOT disconnect the wires from the battery terminals, NOR disconnect the plug connector from the transistor switch as voltage surges may appear in separate elements of the circuit and the transistor switch might get damaged.

Ignition Timing

The ignition advance angle before TDC at a crankshaft speed of 750-800 min^{-1} should be $1\pm1^{\circ}$.

To check ignition timing, there are three marks, 1, 2 and 3 (Fig. 7-18) on the valve gear cover and mark 4 on the crankshaft pulley; when mark 4 is aligned with mark 1 on the cover, this indicates the TDC of the pistons in No.1 and No.4 cylinders.

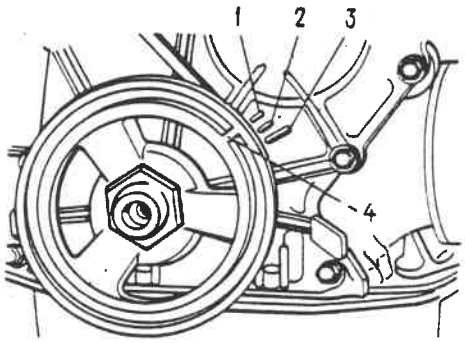

Fig.7-18. Ignition Timing Marks:
1 - TDC mark on crankshaft pulley; 2 - 10° spark advance mark; 3 - 5° spark advance mark; 4 - 0° advance mark

Ignition timing can be checked and adjusted with a stroboscope in the following order:

- connect the stroboscope terminal clamp '+' with the plus terminal of the storage battery and the ground terminal with the minus terminal of the battery and connect the terminal clamp of the stroboscope pickup with the No.1 cylinder H.T. wire. Rub mark 4 on the crankshaft pulley with chalk to make it easily seen;

- start the engine and direct the flashing light of the stroboscope at the mark on the pulley; if ignition timing is correct, mark 4 seen on the pulley will be in line with mark 2 on the valve gear cover when the engine is idling.

To adjust ignition timing, stop the engine, loosen the pickup-distributor fastening nut and turn the distributor through a required angle. To increase or decrease the ignition advance angle, turn the distributor through a required angle. To increase or decrease the ignition advance angle, turn the distributor body counterclockwise or clockwise, respectively. Then recheck the ignition timing.

For the sake of convenience special divisions and marks '+' and '-' are provided on the flange of the pickup-distributor. One division on the flange corresponds to eight degrees of crankshaft turning.

If a diagnostic stand with an oscilloscope is available, it can also be used for an easy check of ignition timing, following the instructions for the stand.

If the ignition pickup-distributor has been removed from the engine, put it back in place as follows:

- turn the crankshaft until a compression stroke begins in No.1 cylinder and, continuing to turn the crankshaft, align mark 4 with mark 3;
- remove the cap from the pickup-distributor and turn the rotor to a position in which its outer contact faces the contact of No. 1 cylinder on the distributor cap;
- holding the distributor shaft against turning, insert it into the socket in the cylinder block so that the axis passing through the spring clips be parallel to the engine axis;
- secure the pickup-distributor to the cylinder block, install the cap, connect the wires, check and adjust the ignition timing.

Stand Tests

Ignition Pickup-Distributor

The ignition pickup-distributor 3810.3706 is shown in Fig. 7-19.

Performance check. Install the pickup-distributor on the electrical equipment test stand and connect it with a regulated speed motor.

Connect the pickup-distributor with the ignition coil, transistor switch and storage battery of the stand as it is connected on the car. Connect four terminals of the cap with the spark gaps in which the electrode gap can be adjusted.

Set a 5-mm gap between the spark gap electrodes, switch on the stand motor and rotate the shaft of the pickup-distributor for several minutes clockwise at a speed of 2000 min^{-1}. Then increase the gap between the electrodes to 10 mm and look for internal discharges in the pickup-distributor. They are revealed by the sound or by weak sparks and misses on the stand spark gap.

During the operation at any shaft speed the pickup-distributor should produce no noise.

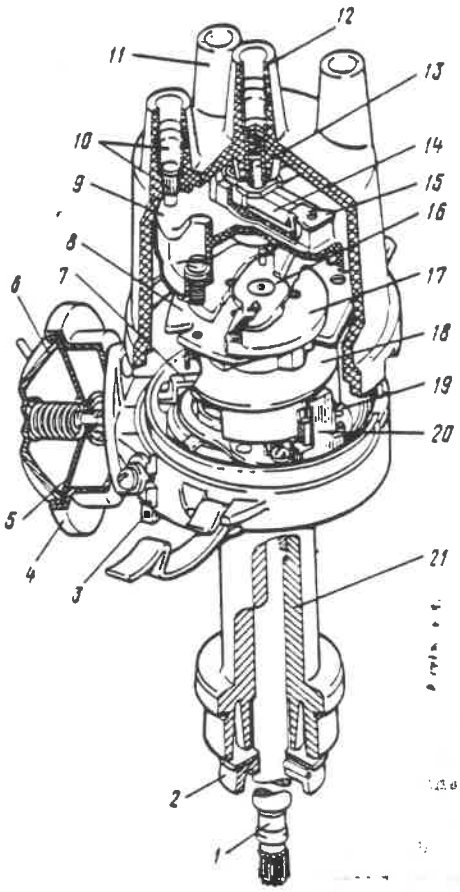

Fig.7-19. Ignition Pickup-Distributor 3810.3706: 1 - shaft; 2 - oil deflecting sleeve; 3 - connector; 4 - vacuum spark timer body; 5 - diaphragm; 6 - vacuum spark timer cover; 7 - vacuum spark timer link; 8 - centrifugal spark timer supporting plate; 9 - ignition distributor rotor; 10 - side electrode with terminal; 11 - cap; 12 - central electrode with terminal; 13 - central electrode carbon brush; 14 - resistor; 15 - rotor outer contact; 16 - centrifugal spark timer plate; 17 - flyweight; 18 - screen; 19 - non-contact pickup supporting plate; 20 - non-contact pickup; 21 - ignition pickup-distributor body

Plotting automatic ignition advance curves. Set the pickup-distributor on the stand, connect its terminals with terminals 3, 5 and 6 of transistor switch 1 (Fig. 7-20) of the stand. Connect transistor switch terminal 4 with terminal '+' of the stand and terminal 1 with the stand breaker terminal. Set a 7-mm gap between the spark gap electrodes.

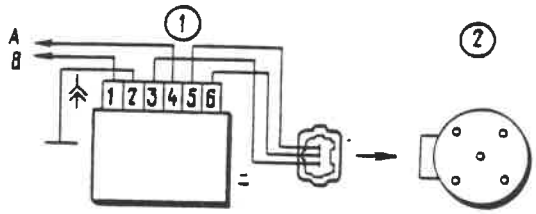

Fig.7-20. Circuit of Stand for Plotting Ignition Pickup-Distributor Curves:
1 - transistor switch; 2 - ignition pickup-distributor; A - to terminal '+' of stand: B - to terminal 'breaker' of stand

Switch on the stand motor and rotate the pick-up-distributor shaft at a speed of 500-600 min^{-1}. By the graduated disk of the stand note the degrees at which one of four sparks jump.

By increasing the speed in 200-300 min^{-1} steps determine the ignition advance degrees corresponding to the speed of the pickup-distributor shaft. Compare the centrifugal spark timer curve with that shown in Fig. 7-21.

If the curve differs from that shown in Fig. 7-21, it can be brought to normal by bending the posts of the flyweight springs of the centrifugal spark timer. At speeds up to 1500 min^{-1} bend the post of the thin spring and at speeds exceeding 1500 min^{-1}, bend the post of the thick spring. To decrease the angle increase the tension of the spring, and to increase the angle, decrease the tension of the spring.

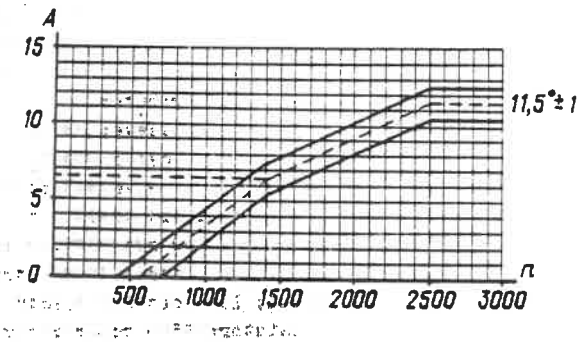

Fig.7-21. Ignition Distributor Centrifugal Spark Timer Curve:
A - spark advance angle, deg.; n - distributor shaft speed, min^{-1}

To plot the vacuum spark timer curve connect the union of the vacuum spark timer with the stand vacuum pump.

Switch on the stand motor and rotate the shaft of the pickup-distributor at a speed of 1000 min^{-1}. Note the degrees on the graduated disk at which one of four sparks jumps.

By gradually increasing the vacuum in 26.7 GPa (20 mm Hg) steps note the ignition advance degrees relative to the initial value. Compare the curve with that shown in Fig. 7-22.

Make sure the plate which carries the non-contact pickup returns definitely in the initial position when the vacuum has been removed.

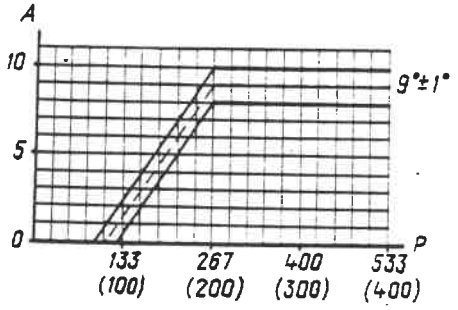

Fig.7-22. Vacuum Spark Timer Curve:
A - spark advance angle, deg.; P - vacuum, GPa (mm Hg)

Non-contact pickup check. Remove the voltage from the pickup output if a steel shield is fitted in its gap. If there is no shield in the gap, the voltage at the pickup output is near zero.

With the pickup-distributor removed from the engine the pickup can be checked in a circuit shown in Fig. 7-23 at a supply voltage of 8-14 V.

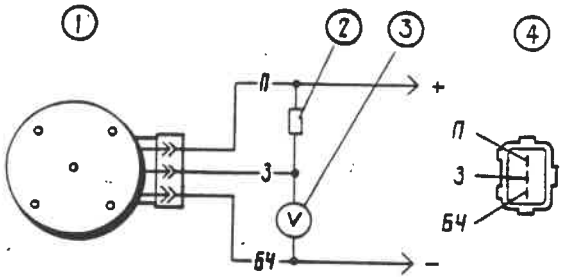

Fig.7-23. Circuit for Checking Non-Contact Pickup on Removed Pickup-Distributor:
1 - ignition pickup-distributor; 2 - resistor, 2 kΩ; 3 - voltmeter, scale range 0-15 V minimum and internal resistance not less than 100 kΩ ; 4 - view of ignition pickup-distributor plug connector

By slowly turning the shaft of the ignition pickup-distributor measure the voltage at the pickup output with a voltmeter. The voltage should change sharply from the minimum, not exceeding 0.4 mm, to the maximum which should be not more than by 3 V less than the supply voltage.

On a car the pickup can be checked using a circuit shown in Fig. 7-24. Connect adapter connector 2 with a voltmeter between the plug connector of the ignition pickup-distributor and the wire bundle connector. Switch on the ignition and slowly turning the crankshaft with a special wrench, measure the voltage at the pickup output which should be within the above-indicated limits.

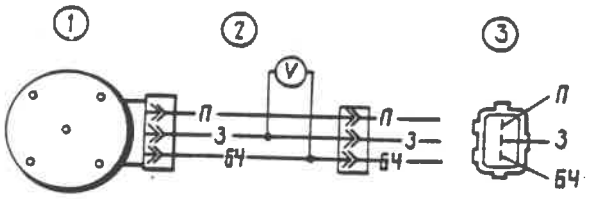

Fig.7-24. Circuit for Checking Non-Contact Pickup on Car:
1 - ignition pickup-distributor; 2 - adapter connector with voltmeter, scale range 0-15 V minimum and internal resistance not less than 100 kΩ ; 3 - view of ignition pickup-distributor plug connector

Ignition Coil

Check winding and insulation resistance.

Resistance of the primary winding at 25°C should be (0.45±0.05) Ω and that of the secondary winding, (5±0.5) kΩ .

Insulation resistance to the frame should be not less than 50 MΩ .

Transistor Switch

The transistor switch is to be checked with an oscilloscope and a square wave generator in the circuit shown in Fig. 7-25. Output resistance of the generator should be 100-500 Ω . A double-trace oscilloscope should be preferably used, with the first trace for the generator pulses, and the second trace for the transistor switch pulses.

Rectangular pulses simulating the pulses from the pickup are applied to terminals 3 and 6 of the transistor switch. Frequency of the pulses is from 3.33 to 233 Hz and pulse period-to-pulse duration ratio (T/T_{pulse}) is 3. Maximum voltage V_{max} is 10 V, minimum voltage V_{min}, not exceeding 0.4 V (Fig. 7-26 II). Waveforms of current pulses for a transistor switch in good repair should be as shown by oscillogram I.

For the transistor switch 3620.3734 the value of current (B) should be 7.5-8.5 A at a supply voltage of 13.5-13.6 V. The current accumulation time is not specified.

For the transistor switch HIM-52 the current value should be 8-9 A at a supply voltage of (13.5±0.2) V and the current accumulation time should be 8-10.5 ms at 25 Hz. For the transistor switch BAT10.2 at the same supply voltage and frequency, the current value is 7-8 A and the current accumulation time is 5.5-7.5 ms.

If the waveform of pulses of the transistor switch is distorted, either misses or delayed sparking might occur. The engine will overheat and will fail to develop rated power.

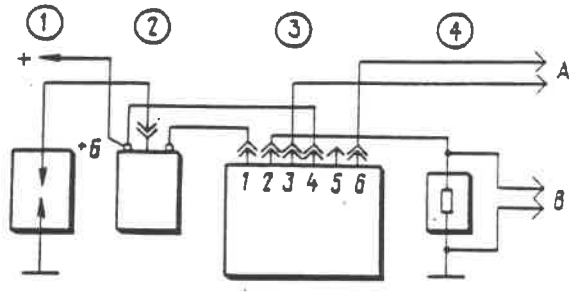

Fig.7-25. Transistor Switch Test Circuit:
1 - spark gap; 2 - ignition coil; 3 - transistor switch; 4 - resistor 0.01 Ω, ±1%, ≥20 W; A - to square wave generator; B - to oscilloscope

Spark Plugs

Before the test clean the carbonized or fouled spark plugs by sand- and airblasting in a special installation.

If carbon deposits are light-brown in colour, they may be left in place since they may appear in a sound engine and do not interfere with normal functioning of the ignition system.

After cleaning examine the spark plugs and adjust the electrode gaps. Replace the spark plug, if the insulator is chipped or cracked or the weld of the side electrode is damaged.

The gap between the spark plug electrodes (0.7-0.8 mm) should be checked with a round wire feeler gauge. Do not check the gap with a flat feeler gauge since this measurement will not include the crater on the side electrode that develops in the course of spark plug operation. Adjust the gap by bending the side electrode only.

Tightness test. Screw the spark plug into the corresponding socket of the stand and tighten to a torque of 31.4-39.2 N.m (3.2-4 kgf.m) with a torque-indicating wrench. Build up a pressure of 2 MPa (20 kgf/cm^2) in the stand chamber.

Apply a few drops of oil or kerosene to the spark plug; in case of poor tightness bubbles will appear, usually between the insulator and the metal body of the spark plug.

Electric test. Screw the spark plug into the stand socket and tighten to the above-indicat-

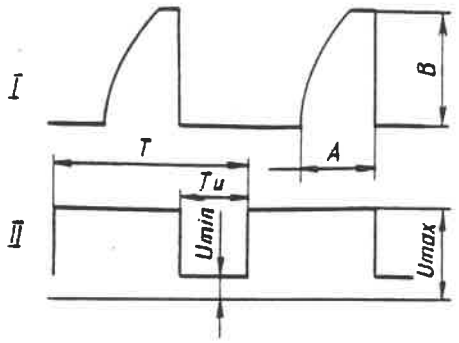

Fig.7-26. Waveforms of Pulses on Oscilloscope Screen:
I - transistor switch pulses; II - generator pulses; A - current accumulation time; B - maximum current value

ed torque. Set a 12 mm clearance in the spark gaps (which corresponds to a voltage of 18 kV) and build up a pressure of 0.6 MPa (6 kgf/cm^2) with a pump.

Fit the tip of a H.T. wire on the spark plug and apply high-voltage pulses to the spark plug.

If good hot spark is seen in the stand observation port, the spark plug is considered good.

If sparking takes place between the spark gap electrodes, reduce the pressure in the device and reveal the pressure at which sparks start jumping between the spark plug electrodes. If the process starts at a pressure below 0.3 MPa (3 kgf/cm^2) the spark plug is defective.

There may be several sparks on the spark gap; if there are no sparks both in the spark plug and spark gap, the fault lies probably in a cracked spark plug insulator so that the discharge takes place inside, between 'ground' and the electrode. Such spark plug is considered faulty.

Ignition Switch

The ignition switch should be checked for proper functioning of the antitheft device and for correct closing of contacts in various positions of the key (Table 7-5). The voltage is fed from the battery and alternator to contacts 30 and 30/1. A vacant additional plug INT is intended for connecting a radio receiver.

Table 7-5

Circuits Energized in Various Positions of Ignition Key

Position of key	Live contacts	Energized circuits
0 (OFF)	30 and 30/1	—
III (PARKING)	30 — INT	—
	30/1	—
I (IGNITION)	30 - INT	—
	30/1-15	Windshield wiper, heater, ignition system, alternator field circuit, instruments, direction indicators
II (STARTER)	30 - INT	—
	30/1-15	Windshield wiper, heater, ignition system, alternator field circuit, instruments, direction indicators
	30-50	Starter

The locking bar of the antitheft device should extend when the key is turned to position III PARKING (СТОЯНКА) and removed from the lock; it should be retracted when the key is turned from position III PARKING (СТОЯНКА) to the OFF (ВЫКЛЮЧЕНО) position.

When istalling the contact unit into the switch body, arrange the unit so that terminals 15 and 30 are located at the locking bar side (Fig. 7-27) in which case the wide lug of the contact unit will snap into the side slot of the switch body.

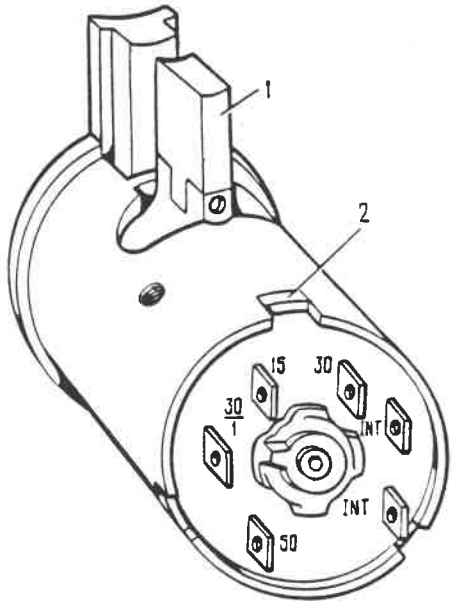

Fig.7-27. Ignition Switch Contact Group:
1 - locking bar; 2 - wide lug

Radio Noise Suppressors Checks

The interference suppressing elements are:

- resistor in the ignition pickup-distributor rotor. Resistance of the resistor is 1 kΩ;
- H.T. wires with distributed resistance of (2000±200) Ω/m for ПВВП-8 wires in red insula-

tion or (2550±270) Ω/m for ПВПВ-40 wires in blue insulation;

- resistors of 4-10 kΩ in the spark plugs;
- 2.2 μF capacitor in the alternator.

The condition of the wires and resistors is checked with an ohmmeter. The procedure for checking the capacitor is laid in the Section 'Alternator'.

LIGHTING AND LIGHT SIGNALLING SYSTEM

Design Peculiarities

The headlight connection diagram is shown in Fig. 7-28. The upper and lower beams of the headlights are switched on by means of auxiliary relays 3 and 11. Control voltage is supplied to the relay windings from headlight beam switch 10 when the rocker of the external lighting switch 5 is pressed to stop.

Irrespective of the position of the rocker of switch 5, the headlight upper beam can be switched on for a short time by pulling the lever of headlight beam switch 10, i.e. perform light signalling. This is provided by that voltage is supplied to the light signalling contact of switch 10 directly from the power sources, bypassing the ignition switch.

Some cars are furnished with a headlight hydraulic adjuster which serves to adjust from the driver's seat the tilting of the headlight beam depending on the car load.

The external lighting circuit diagram is shown in Fig. 7-29. Marker lights are switched on by external lighting switch 3. Simultaneously the lamps of number plate lights 6, instrument cluster illumination, switches and panels lights and marker light warning lamp 5 come on.

The connection diagram of the direction indicators and distress light is shown in Fig. 7-30. The RH and LH direction indicators are switched on by switch 10 on the steering column. When distress light switch 9 is turned on, all direction indicators start flashing. The flashing of the lamps is provided by flasher 8.

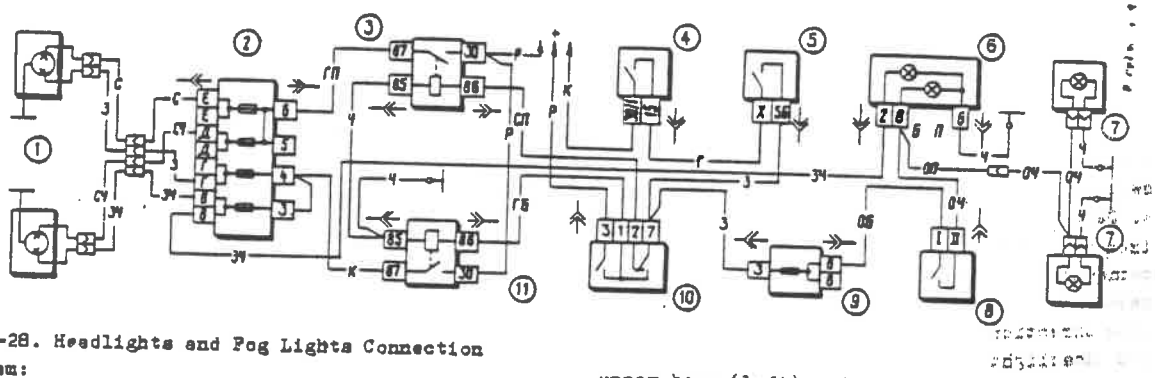

Fig.7-28. Headlights and Fog Lights Connection Diagram:
1 - headlight; 2 - main fuse unit; 3 - headlights lower beam relay; 4 - ignition switch; 5 - external lighting switch; 6 - warning lamps of headlight upper beam (left) and fog light (right); 7 - fog light lamps in tail lights; 8 - fog light switch; 9 - additional fuse unit; 10 - headlight beam switch; 11 - headlight upper beam relay

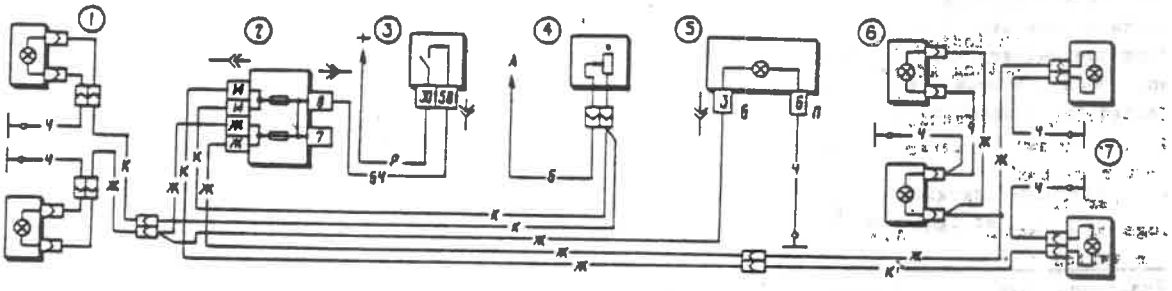

Fig.7-29. External Lighting Circuit Diagram:
1 - marker light lamps in side lights; 2 - fuse unit; 3 - external lighting switch; 4 - instrument illumination switch; 5 - external lighting (marker lights) warning lamp in instrument cluster; 6 - number plate lights; 7 - marker light lamps in tail lights; A - to instrument cluster switches and light panels illumination lamps

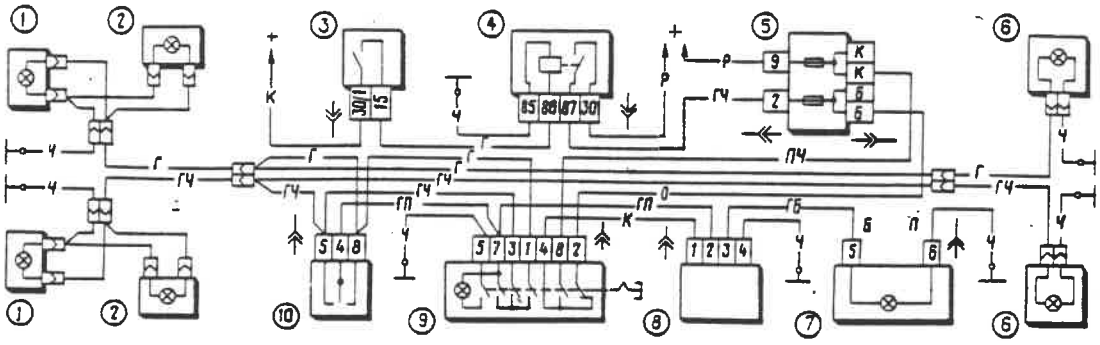

Fig.7-30. Direction Indicators and Distress Light Connection Diagram:
1 - direction indicator lamps in side lights; 2 - side direction indicators; 3 - ignition switch; 4 - ignition relay; 5 - fuse unit; 6 - direction indicator lamps in tail lights; 7 - direction indicator warning lamp in instrument cluster; 8 - direction indicators and distress light flasher; 9 - distress light switch; 10 - direction indicator switch

Trouble Shooting

Cause	Remedy
Some Lights and Headlights Lamps Fail to Be ON	
1. Blown out fuses	1. Check and replace fuses
2. Blown out lamp filaments	2. Replace lamps
3. Oxidized contacts of switches or relays	3. Clean contacts
4. Defective wires, oxidized wire tips or loose connections of wires	4. Check, replace defective wires, clean tips
Direction Indicator Switch Lever and Headlight Switch Lever Fail to Lock in Position	
1. Lever detent ball has slipped out	1. Replace three-lever switch
2. Damaged lever detent socket	2. Same
Direction Indicators Fail to Automatically Stop Lighting After Completion of Turn	
1. Jamming in direction indicator switch lever return mechanism	1. Replace three-lever switch
2. Wear or breakage of lugs of direction indicator switch carrier ring	2. Same
Direction Indicator Lever and Headlight Switch Lever Fail to Shift	
1. Jamming of lever detent ball	1. Replace three-lever switch

Continued

Cause	Remedy
2. Jamming in direction indicator switch lever return mechanism	2. Same
Direction Indicators Warning Lamp Flickers at Twice the Normal Frequency	
1. Blown out lamp of front or rear direction indicator	1. Replace lamp
2. Defective direction indicator and distress light flasher	2. Replace flasher

Headlight Aiming

The headlights should be aimed so as to ensure efficient illumination of the road ahead without dazzling the drivers of the oncoming vehicles by the lower beam. The headlights are aimed by rotating screws 1 and 7 (Fig. 7-31) which turn the light unit in the vertical and horizontal planes.

The best practice is to aim the headlights with the aid of portable optical instruments. However, if they are not available, this work can be done with the aid of a screen.

Place a fully primed and equipped car with a 735 N (75 kgf) load on the driver's seat on a level horizontal ground, 5 m away from a smooth wall or some sort of screen (a sheet of plywood measuring 2x1 m, etc.) so that the car axis is square to the screen. Before marking out the screen, make sure that the car tyres are properly inflated, then swing the car by pushing it from one of its sides to allow the suspension springs to settle.

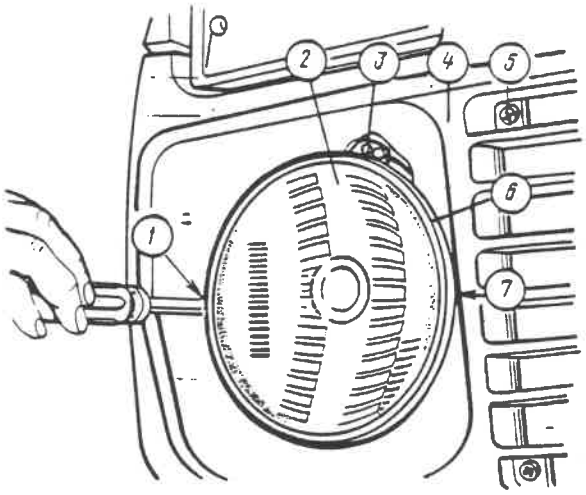

Fig.7-31. Headlight Adjustment:
1,7 - headlight beam adjusting screws; 2 - light unit; 3 - light unit rim attachment screw; 4 - body front decorative facing; 5 - decorative facing attachment screw; 6 - light unit rim

Mark the screen as shown in Fig. 7-32, drawing an axial vertical line O and vertical lines A and B passing through points E which correspond to the headlight centres. These lines should be symmetrical with the car axis. Draw line 1 at the height of the headlight centres above the floor and line 2 of the headlight hot spots at a distance of 65 mm below line 1.

If the car is furnished with a hydraulic adjuster, set its handle on the instrument panel to a position corresponding to car load with the driver only.

Switch on the lower beam. Adjust the light beams by screws 1 (Fig. 7-31) and 7 in turn. For this purpose cover first the LH headlight with a piece of cardboard or dark fabric and adjust the RH headlight, then cover the RH headlight and adjust the LH headlight.

To adjust the headlight beam in the vertical plene turn screws 1 and 7 in the same direction through equal number of revolutions. The difference in the number of revolutions of one screw without adjustment of the other screw should not exceed 3.

To adjust the headlights in the horizontal plane screws 1 and 7 should be turned in opposite directions. For instance, if one screw has been turned through one revolution clockwise, the other screw should be turned one revolution counter-clockwise.

On part of cars the headlights without the hydraulic adjusters and with ther arrangement of the adjusting screws are installed. In these headlights the horizontal adjustment screw is located at the left side, and vertical adjustment screw, at the top.

In correctly adjusted headlights the upper boundary of the hot spots should coincide with line 2 (Fig. 7-32) and the points of intersection of the horizontal and inclined portions of the hot spots should coincide with points B.

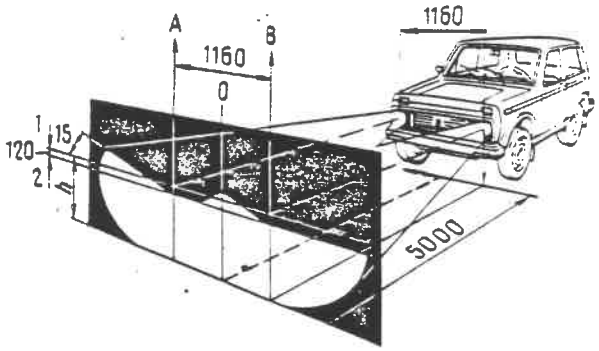

Fig.7-32. Headlight Aiming

Replacement of Lamps

Headlights. To replace the lamp:

- remove decorative facing 4 (Fig. 7-31) of the body front having turned out screws 5;
- loosen screws 3 holding the rim of the headlight unit, turn the rim counter-clockwise and remove it;
- take out the light unit and replace the lamp;
- having replaced the lamp set the light unit so that the yokes of the light unit should get into the sockets of the headlight inner rim.

Side lights. Turn out two screws and remove the lens, then lightly press on the lamp, turn it counterclockwise and take out.

Side direction indicators. Replace a blown out lamp by taking out the holder complete with the lamp from the side of the engine compartment.

Interior light. To replace a blown out lamp in the interior light pull the light carefully. The interior light is held in the hole of the central pillar by two spring holders.

Tail light. To replace a blown out lamp in the tail light remove the plastic plug from the inner side of the trunk compartment, disconnect the connector socket, turn the holder complete with the lamp counter-clockwise and take it out of the seat. Then press on the lamp, turn it counter-clockwise and take out of the holder.

Number plate lights. To replace the lamp turn out the attachment screws, take the light out of the socket and remove the lens.

Headlight Hydraulic Adjuster

The hydraulic adjuster consists of a main cylinder fitted on the instrument panel, slave cylinderr on the headlights and connecting tubes.

The cylinders and tubes are filled with a low-freezing liquid. The hydraulic adjuster is of non-split design and in case of a failure, it should be replaced complete with the cylinders and tubes.

If the tilt of the headlight has increased and the adjusting screws on the headlight fail to bring it to normal, check for liquid leaks in the cylinders and tubes of the hydraulic adjuster. Remove the slave cylinders from the headlights and check the operating stroke of the rods which should be (7±0.5) mm.

To replace a defective hydraulic adjuster disconnect the clamps of the tubes from the wire clips. Remove the main cylinder handle and turn off the nut holding the cylinder on the instrument panel. Disconnect the slave cylinders from the headlights and push them complete with the seal into the car. Install a new hydraulic adjuster in the order reverse to its removal.

Three-Lever Switch

The switch is held by a clamp on the bracket of the steering shaft. To remove the switch proceed as follows:

- remove the steering wheel;
- remove two halves of the steering shaft casing;
- remove the instrument cluster and disconnect the switch wires from the car harness;
- loosen the clamp and remove the switch.

Direction Indicators and Distress Light Flasher

Type 231.3747 flasher 8 (Fig. 7-30) serves to provide flickering of the direction indicators both when cornering and in distress and also for monitoring the condition of the direction indicator lamps. If the lamps are in good repair, the flasher provides flickering of warning lamp 7 at cornering. If the lamps are faulty (blown out, open-circuit fault in supply circuit) the lamp will flicker at twice the normal frequency.

The flasher is secured under the instrument panel on a bolt welded to the wall of the air intake box. A defective flasher is not subject to repair and should be replaced with a new one.

The flasher should provide flickering of the lamps of the direction indicators at a frequency of (90±30) cycles per minute at a nominal load of 92 W, ambient temperature of -20 to +50°C and voltage from 10.8 to 15 V.

Headlight Relays

Type 111.3747 relays 3 and 11 (Fig. 7-28) are used to switch on the headlights. The relays are installed under the instrument panel at the left side. Relays of the same type are used for switching on the tailgate glass heater, headlight wiper and washer.

The relay cut-in voltage at a temperature of (23±5)°C does not exceed 8 V and resistance of the winding (85±8.5) Ω.

HORNS

The car is fitted with two horns type C-308 or C-309. They are bracketed to the radiator frame panel in the engine compartment.

The horn connection diagram is shown in Fig. 7-33.

If the sound becomes weak or hoarse, adjust the horn by turning the screw on the body in or out until a loud and clear sound is obtained.

If adjustment fails to eliminate hoarseness or the horn produces intermittent sound, disassemble it and clean the breaker contacts.

When assembling the horn, take care to install the previously removed gasket between the horn diaphragm and body so as to retain a clearance between the armature and the core.

If the horn fails to sound, check the wires for reliable connection and switch contacts for condition. If necessary, clean the contacts.

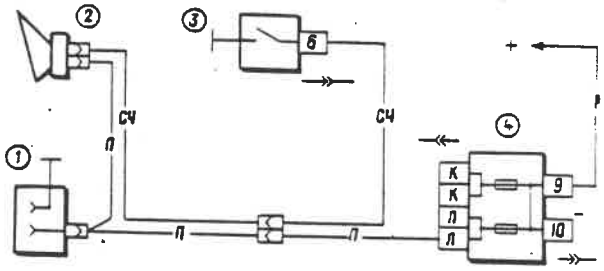

Fig.7-33. Horn Connection Diagram:
1 - inspection lamp socket; 2 - horn; 3 - horn switch; 4 - fuse unit

WINDSHIELD WIPER AND WASHER

Design Peculiarities

The windshield wiper consists of a motor-reduction unit, operating leverage and arms with blades. A connection diagram of the wiper and washer is shown in Fig. 7-34.

The wiper has two operating modes: continuous and intermittent which is provided by type PC-514 relays.

To protect the motor-reduction unit from overloads when the blades are frozen to the glass and

in case heavy resistance to their movement, a thermobimetallic circuit breaker is installed in the wiper.

The washer pump is made en-bloc with the motor and is installed in the engine compartment on the washer tank. The washer pump motor is switched on by the RH lever of the three-lever switch when the RH lever is pulled on.

Trouble Shooting

Cause	Remedy
Wiper Motor Inoperative, Fuse Intact	
1. Damaged motor supply wires, oxidized wire tips	1. Inspect wires, replace damaged ones, clean tips
2. Damaged wiper switch	2. Replace three-lever switch
3. Jamming of motor brushes, heavy oxidation of commutator	3. Inspect, eliminate jamming of brushes or replace faulty parts; dress commutator
4. Breaking of motor-reduction unit leads	4. Inspect and solder up, if necessary
5. Open-circuit fault in motor armature winding	5. Replace armature or motor
Wiper Motor Inoperative, Fuse Blown Out	
1. Short circuit in motor armature winding	1. Replace motor-reduction unit or motor armature
2. Wiper arms distorted and brush against car body	2. Inspect, straighten arms or replace wiper
3. Wiper blades frozen to windshield	3. Pull wiper blades off windshield taking care not to damage blade rubber.
4. Foreign object in wiper mechanism	4. Inspect, remove foreign object

Continued

Cause	Remedy
Wiper Motor Fails to Function When in Intermittent Mode	
1. Wiper switch damaged	1. Replace three-lever switch
2. Wiper relay damaged:	
- open-circuit fault in relay winding	- replace relay
- shorted wires on contact bracket	- eliminate short circuit
- clearance between relay breaker contacts	- eliminate clearance; replace relay, if necessary
Wiper Motor Fails to Stop When in Intermittent Mode	
1. Burnt wiper relay breaker winding	1. Replace relay
2. Cam of motor reduction unit gear fails to force off limit switch spring plate	2. Bend switch plate so that cam can force it off
3. Burning of motor limit switch contacts	3. Dress switch contacts
4. Burning of wiper relay breaker contacts	4. Remedy defect, dress breaker contacts or replace relay
Wiper Motor Stops When in Intermittent Mode. Blades Fail to Stop in Initial Position	
Oxidation or poor closing of limit switch contacts in motor-reduction unit	Clean switch contacts or bend limit switch plate
Wiper Motor Operating, Blades Stay Still	
1. Broken teeth of motor reduction unit gear	1. Replace gear
2. Loosening of crank on motor-reduction unit gear shaft	2. Inspect, tighten crank nut having placed crank in final position

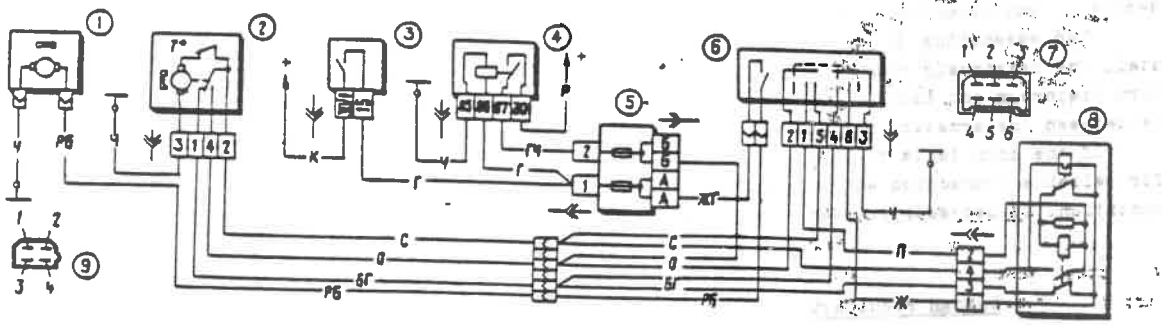

Fig.7-34. Windshield Wiper and Washer Connection Diagram:
1 - windshield washer motor; 2 - windshield wiper motor; 3 - ignition switch; 4 - ignition relay; 5 - fuse unit; 6 - windshield wiper and washer switch; 7 - numbering of plugs in switch sockets; 8 - windshield wiper relay; 9 - numbering of plugs in sockets of relay and windshield wiper motor

Removal and Installation

The repairs of the windshield wiper are confined basically to straightening the distorted components of the leverage or replacing them with new ones. A faulty motor-reduction unit should be replaced by a new one. The only permissible repair operations on the motor-reduction unit are replacing the reduction unit gear, cleaning the commutator and adjustment of the limit switch.

To remove the windshield wiper:

- remove the blades with the arms; open the hood and disconnect the wires from the storage battery and wiper motor:
- unscrew the nuts of the arm pivots and remove the equalizers and rubber gaskets;
- unscrew the nuts of the wiper bracket and take off the wiper.

If necessary, remove the motor-reduction unit from the bracket on a vice and disassemble the leverage.

To install, reverse the removal operations.

Disassembly, Assembly and Inspection of Windshield Wiper Motor-Reduction Unit

To disassemble the motor-reduction unit turn out the screws of reduction unit cover 1 (Fig.7-35) and take off the cover together with panel 2. Then turn out the screws which hold end head 16 to motor frame 7 and detach the end head. Take out motor armature 8.

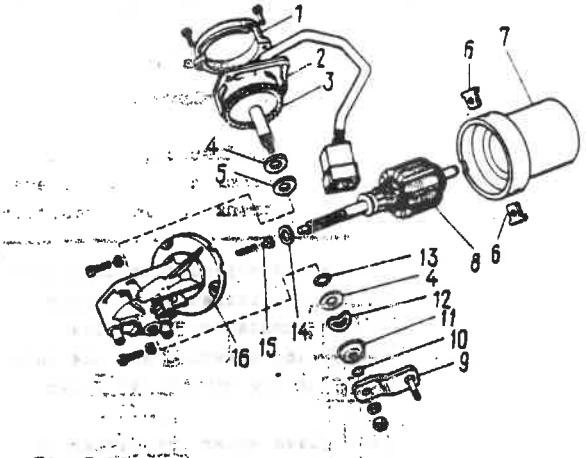

Fig.7-35. Windshield Wiper Motor Parts:
1 - cover; 2 - panel; 3 - reduction unit gear; 4 - steel washer; 5 - textolite washer; 6 - retainer; 7 - frame; 8 - armature; 9 - crank; 10 - retaining ring; 11 - protective cap; 12 - spring washer; 13 - sealing ring; 14 - adjusting washer; 15 - spring seat; 16 - end head

To remove reduction unit gear 3, unscrew the nut of crank 9, take the retaining ring off the shaft and take the shaft complete with the gear and washers out of the frame.

After disassembly, blow out the motor inside spaces with compressed air to remove carbon dust; then examine the brushes and the commutator.

The brushes should be free to move in the brush holders, and the brush springs should be intact and sufficiently resilient. Clean the commutator with fine glass cloth, then wipe it with a clean rag lightly coated with petrolatum. If the commutator is heavily burnt or worn, the best practice is to replace the motor-reduction unit.

Look for the signs of binding on the armature shaft journals. If necessary, clean them with fine abrasive cloth.

During assembly, pull the brushes away from the commutator to avoid breakage and damaging their edges. Insert the armature into the frame with particular care without bumping the armature against the pole pieces so as not to break them.

Having completed the assembly, prior to aligning the bearings, tap the motor frame with a wooden mallet and then test the motor in a stand.

Reference Data

Maximum effective torque on motor-reduction unit shaft*, N.m (kgf.m)	2 (0.2)
Current drain* at a torque of 1 N.m (0.1 kgf.m), maximum, A	2.8
Motor-reduction unit shaft speed* at 1 N.m (0.1 kgf.m), minimum, min^{-1}	50
Starting torque on motor-reduction unit shaft*, minimum, N.m (kgf.m)	12 (1.2)

Windshield Wiper Relay

The PC-514 relay ensures intermittent operation of the windshield wiper. It is installed under the instrument panel at the left-hand side and is held to the car body by two screws.

The relay should provide 9-17 switchings of the wiper per minute at a supply voltage of 10 V and temperature within -20 and +50°C.

Resistance of the relay electromagnet winding is (66±2) Ω and breaker winding resistance is (23±1) Ω.

At the first moment after switching on the wiper for intermittent operation (while the bimetallic plate of the breaker has not yet become heated), the wiper blades may make up to four double strokes in succession.

* At 14 V and (25±10)°C in cold state.

HEADLIGHT WIPER AND WASHER

The headlight wipers consist of two (LH and RH made) motor-reduction units with arms and blades. The arms and blade stop in the lower parking position. Overload protection of the motor-reduction unit is provided either by a thermobimetallic circuit breaker in the motor-reduction unit proper or by a fuse rated for 8 A in the yellow-and-black wire of the motor-reduction unit.

The headlight wiper motor-reduction units are of non-split design. They are not subject to repair and in case of a failure, they should be replaced with new ones.

The pump of the headlight washer with the motor is the same as that of the windshield washer.

A connection diagram of the headlight wipers and washer is shown in Fig. 7-36. They are switched on only when the headlights are switched on by the RH lever of three-lever switch 7, i.e. simultaneously with switching on of the windshield wiper. Voltage is supplied to the winding of auxiliary relay 3. The relay operates and if contact 30 of the relay is under voltage from the external lighting switch (i.e. the headlights are ON), voltage is supplied to headlight wipers 1 and to headlight washer motor 2 through the closed contacts of the relay.

The number of double strokes of the headlight wiper motor-reduction unit shaft at a load torque of 0.49 N.m (0.05 kgf.m), supply voltage of 12 V and ambient temperature of (25±10)°C should be 45-60 min^{-1} and current drain should not exceed 1.5 A.

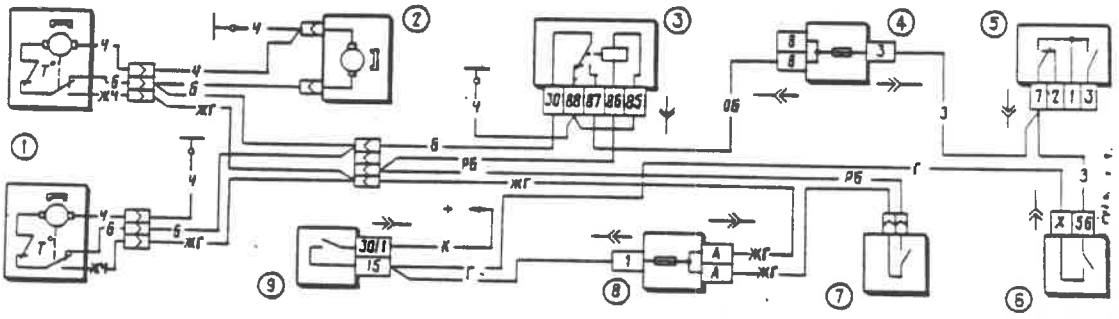

Fig.7-36.Headlight Wipers and Washer Connection Diagram:
1 - headlight wipers; 2 - headlight washer motor; 3 - headlight wipers and washer relay; 4 - additional fuse unit; 5 - headlight beam switch; 6 - external lighting switch; 7 - windshield wiper and headlight wipers and washer switch; 8 - fuse unit; 9 - ignition switch

TAILGATE GLASS WIPER, WASHER AND HEATING DEVICE. CIGARETTE LIGHTER

The tailgate glass wiper consists of a type 471.3730 motor-reduction unit, arm and blade. The arm with the blade park at the RH side viewing in the direction of car running. Overload protection of the motor-reduction unit is provided by a thermobimetallic circuit breaker.

The electric motor of the washer made en-bloc with the pump is secured on the bracket to the panel of the body left side.

The connection diagram of the tailgate glass wiper and washer is shown in Fig.7-37. The wiper is switched on by rocker switch 2 found on the instrument panel at the left side. With the rocker in the middle position only the wiper is switched on, and with the rocker pressed all the way down, the washer is switched on in addition.

The design of the motor-reduction unit permits its disassembly for elimination of minor defects (cleaning the commutator, etc.). The methods of disassembly and assembly are the same as those laid before for the windshield wiper motor-reduction unit.

In the tailgate glass wiper the number of double strokes of the motor-reduction unit shaft should be (50±5) min^{-1} and current drain should not exceed 2 A at a load torque of the motor-reduction unit of 0.49 N.m (0.05 kgf.m), supply voltage of 14 V and ambient temperature of (25±10)°C.

The tailgate glass heating element is switched on by switch 8 through type 111.3747 auxiliary relay 6 installed under the instrument panel

at the left side. For relay specifications refer to Chapter 'Lighting and Light Signalling System'.

The cigatette lighter type 11.3725 is provided with protection against holding the heating element ON for more than 30 s. The protection is ensured by an easily fusible washer secured on the insulator at the rear of the cigarette lighter. If the washer overheats, it melts and connects the centre contact of the cigarette lighter to the ground. As a result fuse No.10 blows and the cigarette lighter gets switched off.

To restore serviceability of the cigarette lighter the cause of long on-holding should be eliminated, the lighter should be disassembled, the molten washer removed and a new one installed.

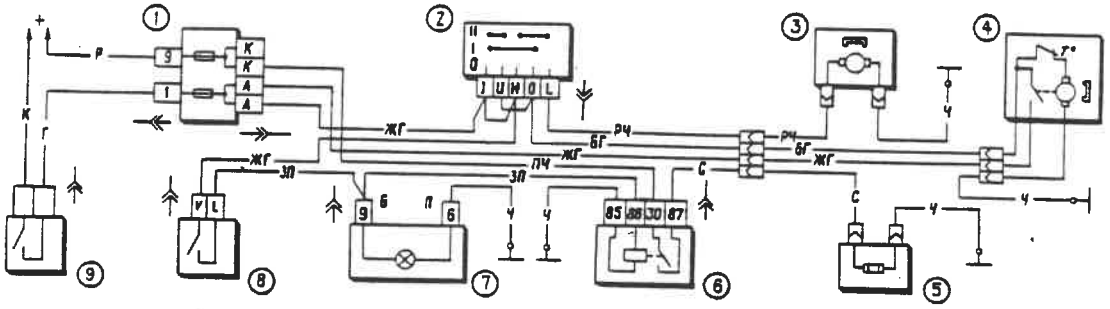

Fig.7-37. Tailgate Glass Wiper, Washer and Heating Element Connection Diagram:
1 - fuse unit; 2 - tailgate glass wiper and washer switch; 3 - tailgate window glass washer motor; 4 - tailgate glass wiper motor; 5 - tailgate glass heating element; 6 - tailgate glass heating cut-in relay; 7 - tailgate glass heating warning lamp; 8 - tailgate glass heating switch; 9 - ignition switch

HEATER FAN MOTOR

The MЭ-255 motor is a D.C. permanent-magnet excitation machine. The heater motor connection diagram is given in Fig. 7-38.

When series resistor 4 is cut into the motor supply circuit, the armature shaft rotates at low speed.

The resistor is secured by two spring washers in the heater fan shroud. The resistor is rated for 1.5 Ω at 20°C.

As a rule, the faulty motor should be replaced. The only permissible repair operation is dressing the commutator.

To disassemble the motor, turn off the screws of the end head and remove the latter. Then remove the lock washer from the armature shaft and take the armature out of the frame. To assemble reverse the disassembly operations.

Inspection of the heater fan motor is similar to that prescribed for the windshield wiper motor.

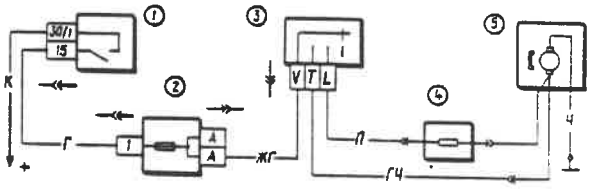

Fig.7-38. Heater Fan Motor Connection Diagram:
1 - ignition switch; 2 - fuse unit; 3 - heater motor switch; 4 - series resistor; 5 - heater fan motor

Reference Data

Speed of armature shaft with impeller at rated power (12 V, 25±10 °C), min^{-1} ..... 3000±150
Current drain at rated power, not over, A 4.5

Trouble Shooting

Cause	Remedy
Motor Inoperative	
1. Wires damaged or connections oxidized	1. Inspect and restore connections. Replace damaged wires
2. Blown out fuse No.1 in fuse unit	2. Replace fuse
3. Heater switch damaged	3. Replace switch

Continued

Cause	Remedy
4. Jamming or wear of motor brushes, open circuit in armature winding or contamination of commutator	4. Check motor, repair or replace it
5. Ground fault in armature winding. Fuse blows out when motor is turned on	5. Replace motor

Continued

Cause	Remedy
Motor Armature Rotation Slowly	
1. Commutator soiled or oxidized	1. Clean commutator
2. Shorted turns in armature winding	2. Replace motor
3. Armature shaft jammed in bearings	3. Disassemble motor, dress shaft journals

INSTRUMENTS

Design Peculiarities

All instruments of the car are combined in the instrument cluster. It includes: speedometer with odometer and trip counter, coolant temperature gauge, fuel level gauge, tachometer, voltmeter with light-emitting diode (LED) indicator and twelve warning lamps.

The instrument cluster is fixed in the instrument panel socket by two nuts. All connections of the cluster are made on a printed circuit board of foil-clad paper-based laminate. The board is secured on the rear side of the housing. A connection diagram of the instrument cluster is shown in Fig. 7-39.

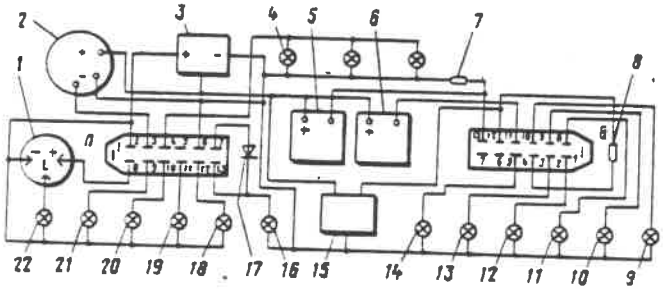

Fig.7-39. Instrument Cluster Connection Diagram (Rear View):
1 - parking brake warning lamp relay-breaker; 2 - tachometer; 3 - voltage stabilizer; 4 - instrument cluster illumination lamp; 5 - coolant temperature gauge; 6 - fuel level gauge; 7 - resistor, 470 Ω, 0.25 W; 8 - resistor 36 Ω, 5 W; 9 - emission control system warning lamp; 10 - tailgate glass heating warning lamp; 11 - fog light warning lamp; 12 - headlight upper beam warning lamp; 13 - external lighting warning lamp; 14 - direction indicators warning lamp; 15 - voltmeter; 16 - brake fluid low level warning lamp; 17 - diode IN4002; 18 - oil pressure warning lamp; 19 - differential lock warning lamp; 20 - low fuel level warning lamp; 21 - seat belt warning lamp; 22 - parking brake warning lamp

The speedometer has an odometer and a trip counter. The latter can be set to zero by the knob brought out through the instrument cluster glass. Resetting should be done only when the car stands still by turning its knob in the clockwise direction.

Caution:

DO NOT use solvents to clean the instrument cluster glass not to cause damage to the glass.

Trouble Shooting

Cause	Remedy
Temperature or Fuel Level Gauge Fails to Operate	
1. Defective gauge	1. Replace gauge or instrument cluster
2. Defective gauge transmitter	2. Replace transmitter
3. Defective wires or oxidized wire tips	3. Check wires, restore connections
4. No contact between printed circuit boards in instrument cluster	4. Remove protective casing of tachometer circuit, turn home board attachment screw, put on casing and fix it on board, by turning screws to stop
Fuel Level Gauge Pointer Returns to '0' With Tank Full	
Incorrect position of float stop (it goes beyond resistor winding)	Bend float stop 1-2 mm down
Fuel Level Gauge Pointer Jumps and Frequently Falls to Zero Mark	
1. Poor contact between transmitter resistor and current collector	1. Bend current collector

Continued

Cause	Remedy
2. Open-circuit fault in transmitter resistor winding	2. Replace transmitter
Low Fuel Level Warning Lamp Constantly Alight	
Ground fault in transmitter wire	Check and eliminate ground fault
Some Warning Lamps Fail to Light	
1. Blown out lamp	1. Replace lamp
2. Defective lamp transmitter	2. Replace transmitter
3. Torn off wires, oxidized wire tips	3. Replace defective wires, clean tips
4. Insufficient pressure of lamp holder contacts to printed circuit board	4. Bend lamp holder contacts or replace holder
Parking Brake Warning Lamp Lights Constantly (Fails to Flicker)	
Open-circuit fault in relay-breaker	Replace relay-breaker
Speedometer Fails to Operate	
1. Loose nuts holding speedometer drive flexible shaft tips	1. Check, tighten up nuts
2. Torn off speedometer drive flexible shaft	2. Replace flexible shaft
3. Defective speedometer mechanism	3. Replace speedometer
Noisy Speedometer Drive Flexible Shaft	
1. Distortion of flexible shaft sheathing (dents, bending, etc)	1. Replace flexible shaft
2. Bending radius of flexible shaft in mounting is less than 100 mm	2.Install flexible shaft correctly

Removal and Installation of Instrument Cluster

To remove the instrument cluster proceed as follows:

- open the hood and disconnect the MINUS wire from the battery terminal;
- remove the instrument panel case; for this purpose turn out two attachment screws at the bottom, then pull the lower edge of the case and release the upper catches;
- turn off two attachment nuts and take out instrument cluster from the socket in the instrument panel;
- disconnect the wires and speedometer drive flexible shaft from the instrument cluster.

To install the instrument cluster proceed in the order reverse to its removal. When installing the flexible shaft do not loop it nor bend the shaft sharply to preclude permanent set of the sheathing. With the instrument cluster installed, the flexible shaft should have no sharp bends. Bending radii of the shaft sheathing in the mounted position should exceed 100 mm.

Disassembly and Assembly of Instrument Cluster

For disassembly remove the knob of the speedometer trip counter by pulling it, then remove the frame with the glass by releasing its lower edge from the fixing spring wire. Remove the instruments having turned out the nuts holding them on the printed circuit board. To assemble the instrument cluster reverse the disassembly operations.

Methods of Trouble Shooting

Coolant Temperature Gauge

If the gauge pointer stays constantly at the beginning of the scale turn on the ignition, disconnect the wire from the gauge transmitter and connect it to the frame through a resistor of 20-50 Ω.

Deflection of the pointer will indicate that the transmitter is defective and should be replaced. If the pointer does not deflect, take the instrument cluster out of the instrument panel, remove the red socket and, with the ignition ON, connect plug 13 (Fig. 7-39) of the white socket in the instrument cluster with the frame through a resistor of 20-50 Ω. Deflection of the pointer in this case will indicate that the instrument is in good repair but the wire connecting the instrument transmitter with the instrument cluster is damaged. If the pointer does not deflect, replace the gauge or the instrument cluster.

When the gauge pointer is constantly in the red zone of the scale, with the ignition ON, disconnect the wire from the transmitter. If the transmitter is defective, the pointer will return to the beginning of the scale. If the pointer remains in the red zone, either the wire has a ground fault, or the gauge is defective. The gauge can be checked for condition by disconnecting the white socket from the instrument cluster. With the ignition ON, the pointer should be at the beginning of the scale.

Fuel Level Gauge

The checking procedure is the same as described above.

When the gauge pointer stays constantly at the beginning of the scale and fails to deflect when the tip of the pink wire disconnected from the transmitter is touched to the frame, check the instrument. For this purpose remove the instrument cluster, disconnect the white socket from the cluster and,

with the ignition ON, connect plug 11 of the white socket to the frame through a resistor of 20-50 Ω. With the gauge in good repair the pointer should deflect.

If the gauge pointer stays constantly at the end of the scale, the gauge can be checked by disconnecting the white socket from the instrument cluster. In the gauge in good repair and the ignition ON the pointer will return to the beginning of the scale.

Instruments Checks

Coolant temperature gauge. The gauge operates in conjunction with the transmitter installed in the cylinder head. At the transmitter resistance of 700 Ω, the pointer should stay at the beginning of the scale, and at a resistance of 77-89 Ω, at the beginning of the red zone of the scale.

Fuel level gauge. The gauge operates in conjunction with the transmitter installed in the fuel tank. When 4-6 l of fuel is left in the tank, the transmitter will switch on the low fuel level warning lamp. At the transmitter resistance of 238-262 Ω the pointem should be at the beginning of the scale, at a resistance of 59-71 Ω, in the middle of the scale and at a resistance of 17-23 Ω the pointer should deflect to the end of the scale (mark 1).

Speedometer. Check the speedometer by rotating its drive shaft with different speeds. For reference data see Table 7-6.

Table 7-6

Speedometer Reference Data

Drive shaft speed, min^{-1}	Speedometer readings, km/h
500	31-33.5
1000	62-65.3
1500	93-97.5
2000	124-129.5
2500	155-161.5

Tachometer. The tachometer employs for its operation the principle of measuring the voltage pulse recurrent frequency in the primary circuit of the engine ignition system.

The tachometer is checked on a stand which simulates the car ignition system. Connect the tachometer to the stand circuit similar to its connection on the car, set a voltage of 14 V in the primary circuit and a 7-mm gap in the stand spark gap. Rotate the shaft of the ignition pickup-distributor at a speed making the pointer deflect to one of the main division marks on the scale. At this moment the deviation of the pickup-distributor shaft speed should be within +250 min^{-1} and -70 min^{-1}.

Voltmeter. To check the voltmeter apply a voltage from a regulated power source to the instrument. At a voltage less than (11.3±0.35) V the LED of the voltmeter should light constantly. When the voltage is within (11.3±0.35) V and (16±0.35) V the LED should not light. At a voltage exceeding (16±0.35) V the diode should flicker. Time delay of the voltmeter is approximately 5 s.

Instrument Transmitters Checks

Coolant temperature transmitter. Used in the transmitter is a temperature sensitive resistor that changes its resistance depending on the coolant temperature. The transmitter reference data are given in Table 7-7.

Table 7-7

Coolant Temperature Transmitter Reference Data

Temperature, °C	Voltage supplied to transmitter, V	Transmitter resistance, Ω
30	8	1350-1880
50	7.6	585-820
70	6.85	280-390
90	5.8	155-196
110	4.7	87-109

Oil pressure warning lamp transmitter. The transmitter is installed in the engine cylinder block. The contacts of the transmitter should close and open at a pressure of 20-60 kPa (0.2-0.6 kgf/cm^2).

Fuel level transmitter. The transmitter is installed in the fuel tank and is secured by nuts. It comprises a variable resistor of NiCr wire. The sliding contact of the resistor is moved by the lever with the float. Fitted on the shorter end of the lever is another sliding contact which switches on the low fuel level warning lamp when 4-6 l of fuel is left in the tank.

When the tank is empty, the resistance of the transmitter should be (250±12) Ω, when the tank is half-full, (66±6) Ω and when the tank is full, the resistance should be (20±3) Ω.

Parking brake warning lamp relay-breaker. The relay-breaker PC-492 serves to provide flickering of the parking brake warning lamp. The relay-breaker is suspended from the wires at the left side under the instrument panel.

The number of ON/OFF cycles of the relay-breaker at a voltage of 10.3-15 V and a temperature within -40 and +40°C should be within 60 to 120. Resistance of the breaker winding is 26 Ω.

Control Unit Checks

Serviceable control unit 5 (Fig. 7-40) should cut out valve 6 when the crankshaft speed rises to 2100 min^{-1} and should cut in the valve when the speed drops to 1900 min^{-1} if the carburettor limit switch is connected to the frame.

Prior to checking the control unit make sure the wires are correctly connected to the unit.

Performance of the control unit is checked with a voltmeter (scale range 0-15 V) as follows:

- disconnect the green wire from the carburettor limit switch and connect the tip of the wire to the frame;
- connect the voltmeter to the control unit through special adapter connector 2 (Fig. 7-41);
- start the engine and, gradually increasing the speed, watch the readings of the voltmeter: after starting the engine the voltmeter should read a voltage of not less than 10 V and at the moment of cutting out of the valve the voltmeter should read a jerky voltage drop to a value not exceeding 0.5 V;
- after cutting out of the valve gradually reduce the speed till the valve cuts in: the voltmeter should read a voltage jump to not less than 10 V;
- set the crankshaft speed within 2200-2300 min^{-1}, disconnect from the frame the tip of the wire laid to the carburettor limit switch and then again touch the wire tip to the frame; with the wire disconnected from the frame, the valve should cut in, with the wire connected to the frame the valve should cut out.

Note. The control unit may be checked without the voltmeter by listening to the specific sound produced by the valve cutting in and out.

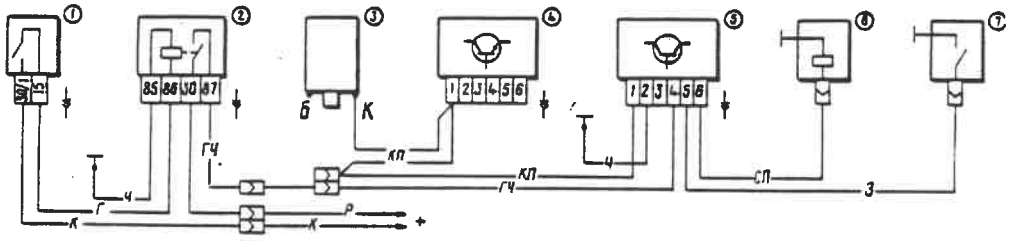

Fig.7-40. Carburettor Electromagnetic Valve Control System Connection Diagram:
1 - ignition switch; 2 - ignition relay; 3 - ignition coil; 4 - transistor switch; 5 - control unit; 6 - electromagnetic valve; 7 - carburettor limit switch

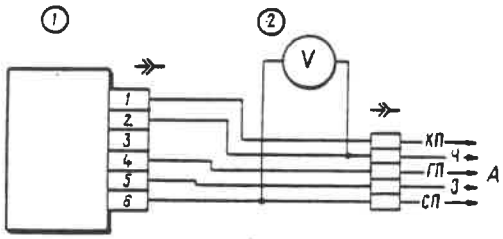

Fig.7-41. Control System Test Circuit Diagram:
1 - control unit; 2 - adapter connector with voltmeter: A - to car wire harness

Section VIII

BODY

TROUBLE SHOOTING

Continued

Cause	Remedy
Dark Stains Over Entire Body Surface	
1. Car washed with very hot water (over 80°C)	1. Eliminate minor defects by polishing; repaint body, if heavily damaged
2. Ethylated gasoline and other paint-attacking materials used for removing protective wax coating	2. Polish body or repaint it, if necessary
Pink Stains on Light-Coloured Surfaces	
Coolant spilt on body surfaces	Polish damaged surfaces
Light Stains on Dark-Coloured Surfaces	
Effect of moisture during prolonged storage of car under airtight covers	Polish damaged surfaces, or repaint car body, if necessary
Enamel Paint Lost Initial Lustre	
1. Wiping of car with dry rags	1. Polish dull surfaces; repaint body, if necessary
2. Prolonged exposure to sunlight	2. Polish; repaint body, if necessary
3. Use of paint-attacking materials for washing	3. Polish dull surfaces; repaint body, if necessary
Water Penetrates into Car Body	
1. Excessively large clearance over door perimeter	1. Adjust position of door and lock striker plate
2. Crushed metal framework of door sealing strip	2. Replace sealing strip
3. Water penetrates past windshield glass sealing strip	3. Pack sealant 51-Г-7 under outer edge of sealing strip
4. Vacuum booster hose pinches valve for draining water from heater air intake box	4. Set vacuum booster hose correctly

Cause	Remedy
Door Opens With Difficulty	
1. Bending of door lock striker plate block axle	1. Replace axle
2. Wear of striker plate block	2. Replace block
3. Wrong door position	3. Adjust door position
Door Lock Cannot Be Locked by Button or With Key	
Upper end of outer remote control lever beers against outer handle shoulder	Bend upper end of lever away from handle shoulder to set a clearance of 0.5–2 mm between them
Door Fails to Be Opened by Outer Handle	
Excessive clearance between door outer handle shoulder and upper end of outer lock control lever	Bend upper end of lever to handle shoulder to set a clearance of 0.5–2 mm
Door Fails to Be Locked	
1. Breaking or weakening of lock central shaft spring or outer control lever	1. Replace lock
2. Loose staking of outer lock control lever shaft. Lever tooth fails to engage ratchet due to axial displacement of lever	2. Remove lock and stake axle reliably
3. Outer control lever jamming due to gumming of lubricant or penetration of dust	3. Remove lock, wash and lubricate it with grease [illegible]-201
Inner Handle Fails to Open Door Completely	
Incomplete travel of inner control lever due to insufficient travel of link	Adjust position of inner lock handle

Continued

Cause	Remedy
Hood Lock Cannot Be Opened by Handle From Inside the Car	
1. Breaking of lock control cable	1. Replace cable
2. Lock control cable too long	2. Adjust cable length by its fastening loop on lock hook
Hood Fails to Be Locked	
1. Lock spring broken or weak	1. Replace spring
2. Lock control cable too short	2. Adjust cable length by its fastening loop on lock hook
3. Lock displaced on car body	3. Adjust position of lock
Roll-Down Window Glass Cannot Be Fixed in Desired Position	
Window regulator spring brake broken	Replace window regulator
On Pulling Rake-Adjusting Handle, Front Seat Back Fails to Return from Reclined Position	
Breaking of mechanism spring	Replace spring, check functioning of mechanism
Front Seat Back Fails to Be Fixed in Desired Position	
Breaking of back retainer teeth	Replace seat framework

Continued

Cause	Remedy
Difficult Adjustment of Front Seat Position	
Slides jammed in rail guides due to lack of lubricant	Lubricate slides and guides with grease ЛИОЛ-1
Hot Air Constantly Supplied into Car Interior	
1. Heater cock controls faulty	1. Examine control mechanism, fasten rod casing; replace rod, if necessary
2. Heater cock fails to shut off coolant flow	2. Replace cock
Only Cold Air Supplied Into Car Interior	
1. Heater cock fails to open due to breaking of cock controls	1. Examine control mechanism, fasten rod casing; replace rod, if necessary
2. Cock faulty	2. Replace cock
Insufficient Air Supply Into Car Interior	
Faulty control linkage of air intake lid (lid closed)	Examine control linkage, fasten rod casing; replace rod, if necessary

REPAIR OF BODY AND ITS COMPONENTS

The design of the body shell and sheet metal parts is shown in Figs 8-1, 8-2, 8-3.

Gauging and Straightening

A considerable part of body repairs falls to the cars after collisions which in most cases have to be checked for the geometry of the fastening points of the chassis units and mechanisms. Main reference dimensions are given in Fig. 8-4.

As defects and damage of the car body are different, adequate repair steps should be taken in each particular case; straightening out of damaged surfaces should be carried out in the maximum amount trying to avoid thermal treatment of the metal not to disturb manufacturer's welding seams and not to cause damage to the corrosion-preventive coating of the body. The face panels of the body should be removed only when it is required to locate the place of damage, straighten out or gauge the body.

In case of heavy damage all inner trim, upholstery and lining elements should be removed to facilitate measurement, checking and installation of hydraulic and screw jacks to eliminate bending and cocking.

Projection of the face panels and detachable parts relative to the adjacent panels is eliminated by fitting-in and adjusting.

Repair of Deformed Surfaces

Damaged parts of the body are repaired by drawing, straightening, dressing with metal shrinkage, cutting out the non-repairable sections, making repair inserts from discarded parts of the car body or sheet metal and imparting to them the shape of the parts to be restored.

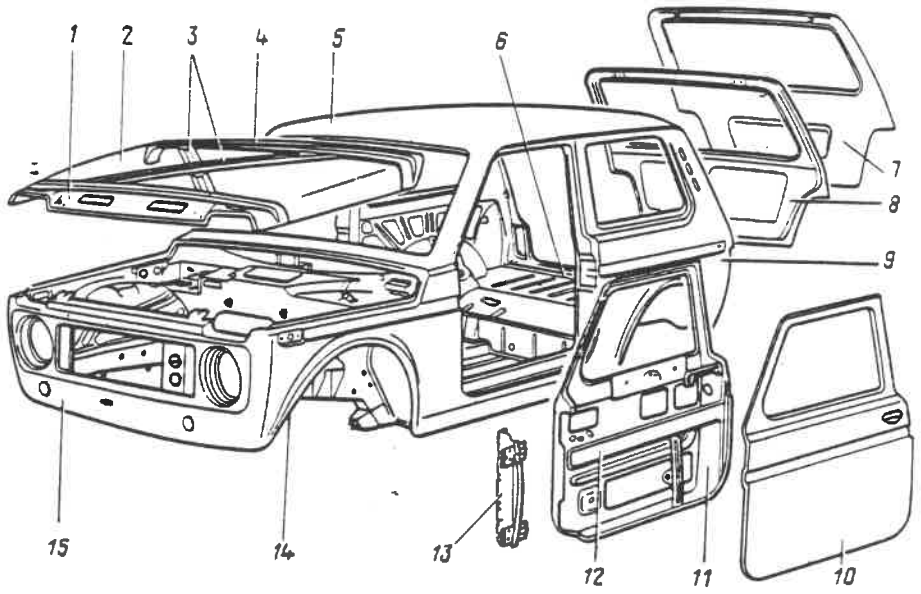

Fig.8-1. Body:
1 - hood front reinforcement; 2 - hood panel; 3 - hood diagonal reinforcements; 4 - hood rear reinforcement; 5 - roof panel; 6 - body rear panel; 7 - tailgate outer panel; 8 - tailgate inner panel; 9 - body side; 10 - front door outer panel; 11 - front door inner panel; 12 - door rail; 13 - front door extension; 14 - front fender; 15 - radiator grille panel

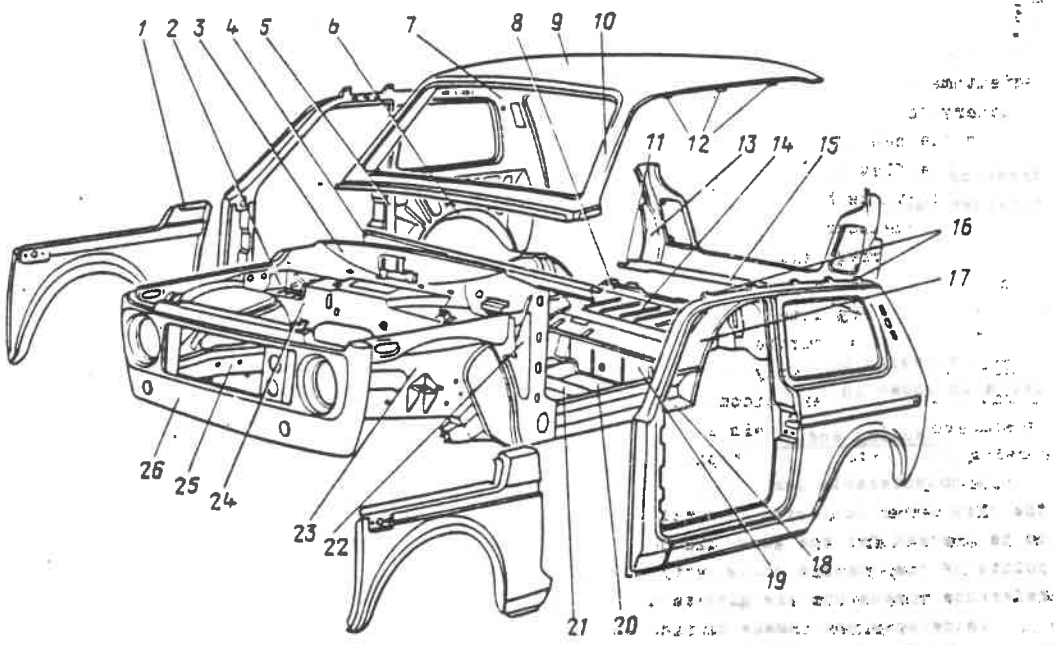

Fig.8-2. Body Parts:
1 - front fender; 2 - storage battery pan; 3 - dash panel upper reinforcement; 4 - instrument panel crossmember; 5 - central pillar; 6 - rear wheel outer arch; 7 - body side inner panel; 8 - floor rear crossmember; 9 - roof panel; 10 - windshield frame; 11 - wheel splashguard bracket; 12 - roof reinforcements; 13 - rear pillar; 14 - floor rear panel; 15 - body rear crossmember; 16 - door lining bow brackets; 17 - rear wheel inner arch; 18 - floor and body side connector; 19 - floor crossmember under rear seat; 20 - floor front panel; 21 - floor crossmember under front seats; 22 - body front side panel; 23 - front fender mudguard; 24 - dash panel; 25 - front sidemember; 26 - radiator grille panel

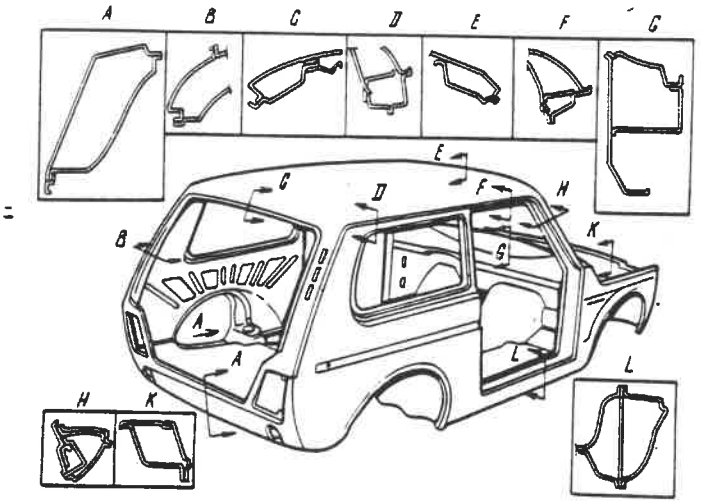

Fig.8-3. Body Main Sections

The deformed panels are usually trued up manually, by special tools (metal, plastic, wooden hammers and mallets and different dollies and drivers).

Hot straightening is resorted to for contracting heavily stretched surfaces of panels. To rule out sharp bulging and deterioration of mechanical properties, the panels are heated to cherry red colour (600-650 °C). The heated spot should not be larger than 20-30 mm in diameter.

Contract the surface as follows:

- heat metal with a carbon electrode of a semiautomatic welder or with a gas burner from the periphery to the centre of the defective spot and flatten the heated surfaces with a wooden maul and hammer on a flat backing or anvil;
- repeat the heating and upsetting operations until the panel surface becomes smooth.

Surface irregularities on the panels can be smoothed out with polyester putties, thermoplastic, cold-setting epoxy cements and solder.

The polyester putties type Хемпропол-П or ПЭ-0085, stick reliably to the panels dressed to bright metal. They are bicomponent materials, viz. unsaturated polyester resin and a curing agent serving as a catalyst for rapid hardening of the mixture.

The temperature in the working room where the treatment is carried out should be not lower than 18°C. The prepared polyester putty should be used within 10 min, maximum. Complete hardening of the putty layer applied to the surface takes 60 min. Thickness of the putty layer should not exceed 2 mm.

Thermoplastic is available in powder form. It acquires its elastic properties required for application to the metal surface at a temperature of 150-160°C. The surface to be treated should be cleaned thoroughly from rust, scale, old paint and other contaminants. Roughed surface of the metal improves adhesion of the thermoplastic. Prior to applying the thermoplastic heat the metal surface to be trued up to 170-180°C and apply the first layer of the plastic powder which should be rolled down with a metal roll after application. Then apply the second layer and proceed in the similar manner until the irregularity is levelled up (eliminated). Roll down each layer until a monolyth layer of plastic mass is obtained. After hardening, the layer is treated in the usual manner.

Solders ПОССу 18-2 and ПОССу 25-2 are used to straighten the spots already filled with solder, to build up the edges of parts and to fill up clearances.

Heavily distorted panels should be replaced by new ones installed with the use of gas-shielded arc welding.

Replacement of Front Fender

If the fender is slightly damaged (shallow dents, scratches, etc.), straighten it out directly on the car and have it painted. After straightening, check the condition of the inner anticorrosion coating and restore it, if necessary.

In case of serious distortions and fractures, replace the fender.

Remove the bumper, hood and front door.

Using a sharp chisel or a grinder, cut off the fender along the lines shown in Fig. 8-5.

Detach the fender, remove the remaining metal strips, straighten out the distorted edges and dress them with an electric or pneumatic grinder.

Install the front door and a new fender and fasten it with qucik-fix clamps.

Gas-weld the fender at the points shown by arrows in the Figure. Use solder bars Л62, Л63 of 2-3 mm diameter as a filler material.

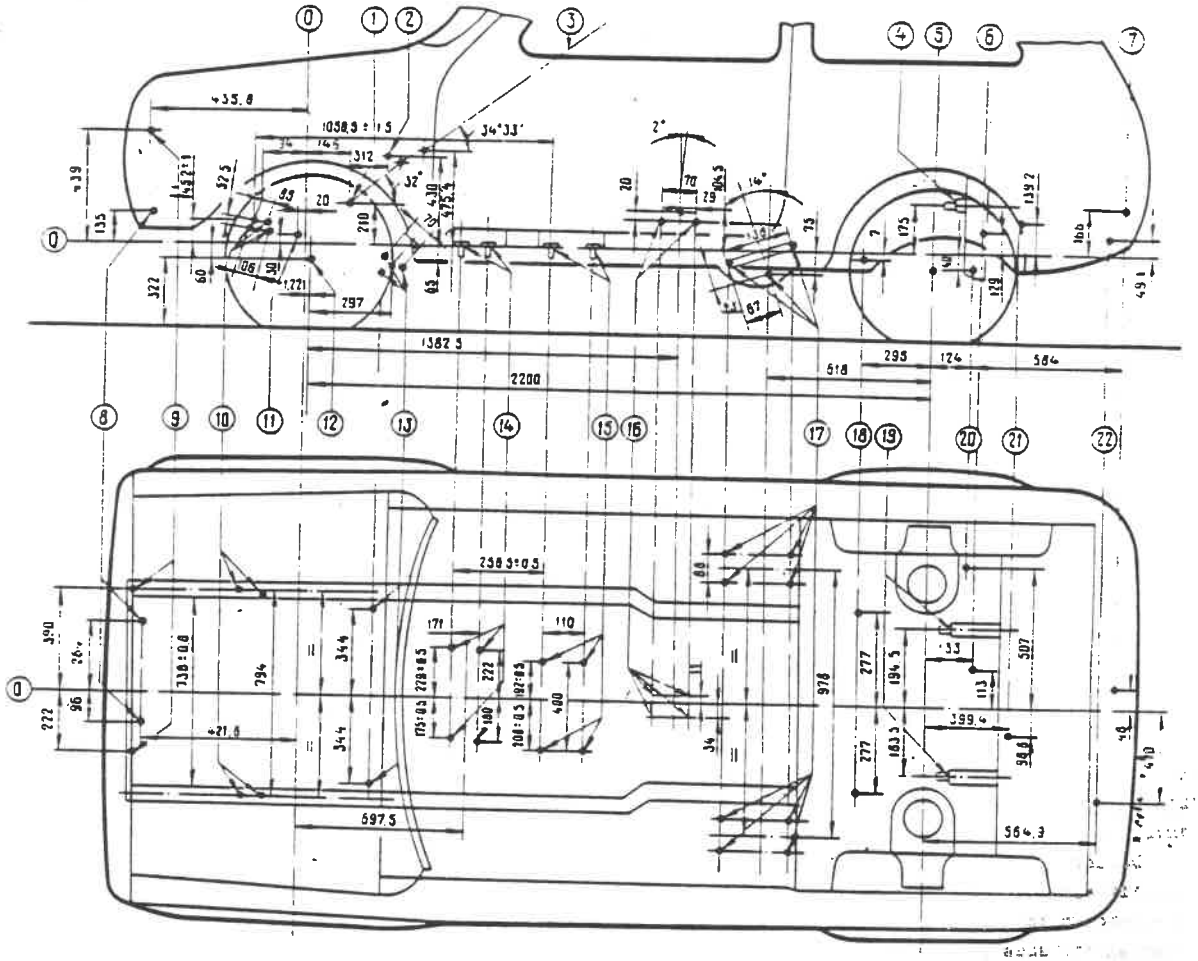

Fig.8-4. Chassis Units Attachment Points:
0 - basic lines; 1 - steering mechanism centre; 2 - clutch and brake pedals axis; 3 - steering shaft axis; 4 - rear suspension shock absorber attachment; 5 - rear wheel axis; 6 - main muffler front pipe attachment; 7 - main muffler rear attachment; 8 - radiator bottom attachment; 9 - radiator top attachment; 10 - front suspension crossmember attachment; 11 - differential centre; 12 - wheel centre; 13 - sway eliminator attachment; 14 - engine unit rear mount attachment; 15 - transfer case attachment; 16 - hand brake lever bracket attachment; 17 - rear suspension longitudinal radius rods front attachment; 18 - rear suspension longitudinal radius rods rear attachment; 19 - rear suspension shock absorber attachment; 20 - rear suspension transverse radius rod attachment; 21 - main muffler front attachment; 22 - main muffler exhaust pipe attachment

Install the hood and check the position of the fender. It may protrude or sink relative to the door or hood not in excess of 2 mm; the gaps between the fender and the hood and door over the face surface should not exceed (5±2) mm.

Remove the hood and the door.

Weld the fender, using resistance welding with a pitch of 40-50 mm, to the front pillar, splash guard and dash panel. It is also permissible to use gas welding with brass solder or carbon-dioxide shielded arc welding with intermittent 10-mm welds applied every 50-60 mm. Weld the fender with semiautomatic arc welders using welding wire св.08 ГС or св.08 Г2С, 0.8 mm in diameter.

Gas-weld the fender to the body front panel with intermittent welds by flashing off the edges.

Replacement of Roof

As a rule, the roof of a crashed car has to be replaced.

Remove the tailgate, drip channel-mouldings, windshield, roof linir and accessories.

Place a new roof panel on the body and determine the points where the pillars and roof side panels have to be cut.

Cut off the roof panel along the lines shown in Fig. 8-5.

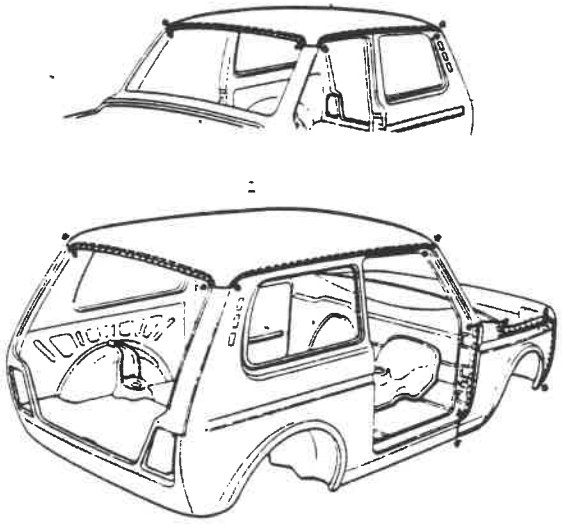

Fig.8-5. Front Fender and Roof Panel Welding Lines. Dots show resistance welding seams. Arrows show gas-tacking points

Detach the roof panel, remove the remaining panel strips and straighten out the distorted surfaces.

Remove the paint and prime-coat from metal on the edges of the roof panel, windshield frame, roof side panels and reinforcements to be welded.

Replace gaskets on the roof reinforcements.

Install the roof panel, fasten it with quick-fix clamps and gas-tack the panel at the points shown by arrows in Fig. 8-5.

Weld the roof panel by resistance welding at a pitch of 40-50 mm or by gas welding at points spaced 50-60 mm through the previously drilled holes of 5-6 mm diameter. To rule out distortion of parts, work from the middle of the weld to the right and left.

Dress the welds with an electric or pneumatic grinder.

BODY PAINT COATING

Polishing

To preserve the paint coating of the body and provide its attractive appearance for a long period, use the polishing compounds which suit the condition of the paint coating and strictly follow the instructions for their use.

During the first 2-3 months of service wash the body with cold water. To treat a new coating (of a car up to 3 years in service) use non-abrasive polishes recommended for new coatings.

In the period of 3 to 5 years of service use autopolishes for weather-beaten coatings containing a little amount of abrasives; after 5 years of intensive service use autopolishes for old coatings.

To prevent drying of the polish on the coating, apply it to small areas of the body and polish with a piece of clean flannel cloth by hand.

To eliminate minor defects of the paint coating, use polishing pastes ВАЗ-1, ВАЗ-2 and a polishing compound ВАЗ-03. Polishing can be done manually or mechanically, using flannel cloth or beaver-lamb wheels.

Take care to mix the polishing paste before the application; if it becomes thick, dilute it with water. After polishing wipe the surfaces with clean flannel cloth.

Repainting With Synthetic Enamels

Wash the body with water and remove the old flaking paint from the defective surfaces with a putty knife or a brush.

Wet-rub the surfaces to be painted using grinding cloth 68С 8-П or 55С 4-П. If the coating is thin and bears no mechanical defects, dress the surface to the epoxy primer layer applied at the autoplant. If the surfaces are seriously corroded or the body has previously been painted with nitrocellulose enamel, dress it down to bare metal.

Wash the body with water, airblast it and leave to dry.

Degrease the surfaces to be painted with white spirit or БР-1 gasoline-solvent and apply "plastisol (Пластизоль) Д-4 А" sealant to the welds and joints of the parts replaced. Remove surplus sealant with rags soaked in white spirit.

The surfaces not to be painted should be masked with thick paper and adhesive tape.

Using a spray gun apply primer ГФ-073 or ВЛ-023 to the surfaces dressed down to bright metal and let it dry for 5 min. Viscosity of the primer should be 22-24 s at 20 °С, as read by viscosimeter ВЗ-4. Dilute the primer with xylene.

Using a paint spray gun, apply epoxy primer ЭП-0228 to the surfaces coated with primer ГФ-073 or ВЛ-023 and to the replaced body parts and dry them at 90 °С for 60 minutes. Before applying the primer ЭП-0228, mix it with 6-8% of drier НФ-1, or 3-4% of catalyst МТТ-75 by weight. The primer with catalyst is fit for use in the course of 7 h. The primer viscosity should be 23-25 s at 20°С, as read by viscosimeter ВЗ-4. The primer can be diluted with solvent Р3-11В or xylene.

Cool down the body, wet-rub it with abrasive cloth 55С 4-П, wash with water, airblast and leave to dry.

When necessary, eliminate surface irregularities with a putty, let the body dry and grind the putty-covered surfaces with grinding cloth 55С 4-П. Wash the body, blow it out with compressed air and dry.

Mask the not-to-be painted surfaces of the body with thick paper and adhesive tape and place the body into the painting chamber.

Degrease the surfaces to be painted with white spirit.

Apply two layers of enamel МЛ-197 or МЛ-1195 from a spray gun, to the internal painted surfaces of the car interior, door frame, door edges, engine compartment and trunk, making an interval of 7-10 minutes between successive applications.

Apply three layers of enamel to the external surfaces of the body, making 7-10 minute intervals between successive applications.

Dry the paint coating at 90 °C in the course of 60 min and cool it down under natural conditions.

Before using the enamel, mix it with 10 % of catalyst ДГУ-70; 20 % solution of maleic anhydride in cellulose acetate can be used for МЛ-197 enamels. The enamel viscosity should be 20 s as read by viscosimeter ВЗ-4. Dilute the enamel with solvent Р-197.

If the old paint should be removed, use paint remover СП-7. Apply the remover with a brush 2-3 times, depending on the thickness of the old paint.

The coating will soften in 30-40 min after which it can be scraped off with a brush or a putty knife.

Wipe the surfaces with white spirit to take off the remaining paint remover, wash them with water abundantly and dry the body.

Painting of Separate Parts

After the replacement of separate parts (fender, door, hood, etc.), as well as after straightening the distorted parts, paint each part over the entire external surface.

Before painting the newly installed parts, grind them slightly and coat all over with epoxy primer.

Paint the parts following the procedure laid above for body repainting.

ANTICORROSIVE TREATMENT OF BODY

The elements most likely to be attacked by corrosion include the hollow parts of the body, bottom, lower parts of the doors and pillars, as well as the joints of body parts including the spot welds.

Corrosion is apt to spread intensively in the boxed spaces and lower parts of the body when they get in contact with moisture, dirt, salts and acids.

This calls for an additional protection of the internal surfaces and boxed spaces of the body by applying special anticorrosive compounds and by filling the joints with sealants.

The materials used for anticorrosive treatment are given in Table 8-1.

Table 8-1

Anticorrosive Treatment Materials

Name	Grade	Viscosity, at 20 °C, read by viscosimeter ВЗ-4, s	Thinner or solvent	Drying conditions	
				temperature, °C	time, min
Sill preservative	Movil, Movil-2	15-40	White spirit, gasoline	20	20-30
Non-drying protective lubricant	НГМ-МЛ	45	White spirit	20	15
Protective film coating	НГ-2І6Б	18-22	White spirit, gasoline	20	20
Soundproofing bituminous sealant	БПМ-1	High-viscosity	Xylene, solvent	100-110 (or 24 h at 18-20 °C)	30
PVC plastic material	Plastisol Д-11А	Ditto	-	130	30
PVC plastic material	Plastisol Д-4А	Ditto	-	130	30
Non-drying sealant	51-Г-7	Ditto	-	-	-

The Movil or Movil-2 autopreservative is recommended for treating the boxed spaces. A good practice is to treat them every 1-1.5 years. This autopreservative may be used for application to the surfaces previously coated with nigrol and other oils and to the rusty surfaces.

The protective lubricant НГМ-МП is used for treating the boxed spaces. All new cars are treated with this lubricant.

The protective film coating НГ-216Б is applied to the car parts under the body.

The soundproofing bituminous sealant БПМ-1 is used for anticorrosive protection of the body underside and for reducing the noise. The sealant layer is 1.0-1.5 mm thick.

Plastisol Д-11А protects the body underside against corrosion, abrasive wear and ensures soundproofing. The thickness of coating is 1-1.2 mm. Bottoms of new cars are treated with plastisol Д-11А.

Plastisol Д-4А is used for sealing the welded joints.

The non-drying sealant 51-Г-7 seals the body joints.

The internal spaces are coated with anticorrosive materials by air or airless spraying.

Air spraying with compressed air at a pressure of 0.5-0.8 MPa (5-8 kgf/cm^2) is carried out with a spray gun and a reservoir, hoses and spray gun extension nozzles. The best coating is achieved by airless spraying under a pressure up to 4-12 MPa (40-120 kgf/cm^2) which makes it possible to spray highly viscous materials.

Preparation and Anticorrosive Treatment of Boxed Spaces

Inasmuch as treatment of boxed spaces calls for the use of sophisticated technological equipment and for high quality of work, this treatment should be performed only at service stations.

The procedure is as follows:

- place the car on a lift, remove the parts and upholstery that interfere with access to the boxed spaces;
- wash the boxed spaces (Table 8-2) and body underside with water at 40-50°C through auxiliary and drain holes until the water flowing out becomes clean. The drop windows should be lifted up all the way;
- remove any moisture that penetrated into the body and trunk, airblast all the boxed spaces and

Table 8-2

Boxed Spaces Treated with Anticorrosive Compounds

Space	Where injected	Direction of injection	Additional instructions
Body front upper crossmember	Through two upper holes	Right and left	Open hood
Headlight housings	In front (from outside)	All over	Remove headlights
Body front lower crossmember	Through two holes for installation of bumper	Right and left	Remove front bumper
Under front fenders	Through opening closed with shield	All over	Remove sealing shield
Door outer sills	Through six side holes	Forward and backward	Remove mouldings and fasteners
Door inner sills	Through rear hole in sill end	Along sill	
Front side members	Through bumper installation holes	Along side members	Remove front bumper
Front side member connectors	Through holes on body underside	Right and left	Put car on lift
Middle and rear side members	Through seven holes in body underside	Forward and backward	Put car on lift
Middle side member connectors	Through holes in body underside	Right and left	Put car on lift
Rear floor crossmember	Through holes in trunk and body underside	Right and left	Remove trunk lining
Body rear crossmember	Through two holes in body underside	Right and left	Put car on lift
Between rear wheel arches and body sides	Into openings in trunk	All over	Remove trunk lining
Centre pillars	Through hole behind pillar	Downward	Remove lining

Continued

Space	Where injected	Direction of injection	Additional injections
Front pillars	Through two holes from interior side	Downward	Remove lining
Door pockets	Through openings in door inner panel	All over internal surface	Remove door trim panels

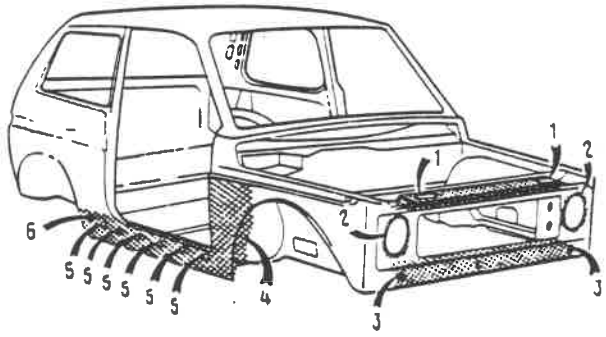

Fig.8-6. Boxed Spaces (Body Front View):
1 - body front upper crossmember; 2 - headlight housings; 3 - body front lower crossmember; 4 - under front fender; 5 - outer sill; 6 - inner sill

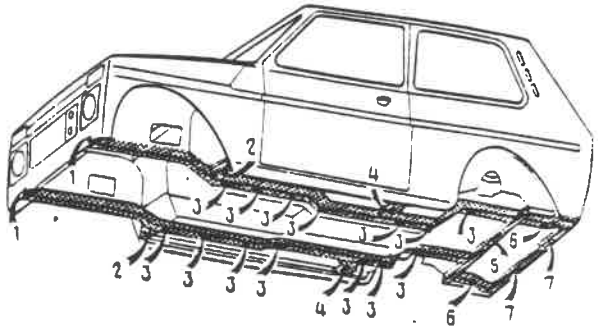

Fig.8-8. Boxed Spaces (Body Bottom View):
1 - front sidemembers; 2 - front sidemember connectors; 3 - middle sidemembers; 4 - middle sidemember connectors; 5 - rear floor crossmembers; 6 - rear sidemembers; 7 - body rear lower crossmember

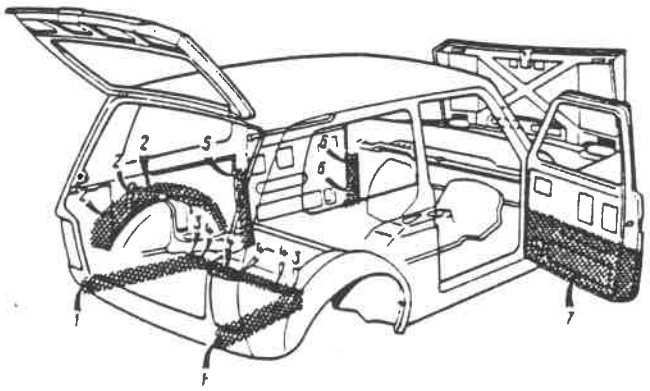

Fig.8-7. Boxed Spaces (Body Rear View):
1 - rear sidemembers; 2 - between rear wheel arches and body sides; 3 - rear sidemembers; 4 - rear floor crossmember; 5 - central pillars; 6 - door front pillars; 7 - door pocket

the surfaces to which the anticorrosive compounds will be applied;

- drive the car to the anticorrosion-treatment chamber and put it on a lift. Spray the anticorrosive compound onto the surfaces shown in Figs 8-6, 8-7 and 8-8;

- lower the car from the lift and clean the external surfaces of the body with rags soaked in white spirit.

Restoration of Anticorrosive and Sound-Proofing Coatings of Body Underside and Wheel Arches

In the course of service, the coatings on the body bottom suffer from gravel, sand, salt and moisture. As a result the sealant and primer are damaged and abraded. The bare metal is attacked by corrosion.

With a view to soundproofing and corrosion protection the lower part of the body base and side members are coated at the autoplant with a layer of PVC material Plastizol Д-11А, 1-1.5 mm thick, on top of epoxy primer ГФ-083.

If the bottom coating is damaged but the layer of the primer remains intact, clean the damaged surfaces of dirt, and apply a 1.5 mm layer of sealant ВГМ-1 to the dry surface. Let the coating dry under natural conditions for 24 h, or dry it for 30 min at 90 °C.

If the coating layer and even the primer are damaged, clean the affected spots from dirt and rust to metal, degrease them, let dry and apply ГФ-073 primer to the surface with subsequent application of sealant ВГМ-1 to the prime-coated surfaces. Use a brush for this purpose.

If the car has been operated for a period not exceeding 1-1.5 years, see to it that the new layer of the sealant overlaps the old one to a minimum. After a longer service apply the sealant all over the bottom and wheel arches.

In cold season, keep the sealant before application in a warm room at a temperature not below 20 °C. If the sealant gets thick, dilute it with up to 3% of xylene.

Clean the paint coating of the body of stains of sealant with waste cloth wetted with white spirit.

Sealing of Body

The body is sealed by various sealing strips (Fig. 8-9), cements, sealing compounds, rubber plugs installed in auxiliary holes, and by carefully fitting the mating parts.

When removing and installing the sealing strips, avoid crushing their metal reinforcements and corrugating the strips.

The welded joints do not provide adequate sealing of the parts and if moisture penetrates to the parts, the latter get corroded. To seal the joints from moisture and dirt they are coated with plastisol Д-4А.

When replacing body parts, coat the welds on both sides with Plastisol Д-4А and apply the non-drying sealant 51-Г-7 (Figs 8-10, 8-11) at the corners, between the following parts:

- door sills and dash panel (on the body interior side);
- dash panel and front pillar panel and storage battery pan;
- front side member joints, and radiator frame and dash panel;
- dash panel joints and body front cover plate;
- rear floor and its extensions with rear wheel arches, body sides and rear crossmember.

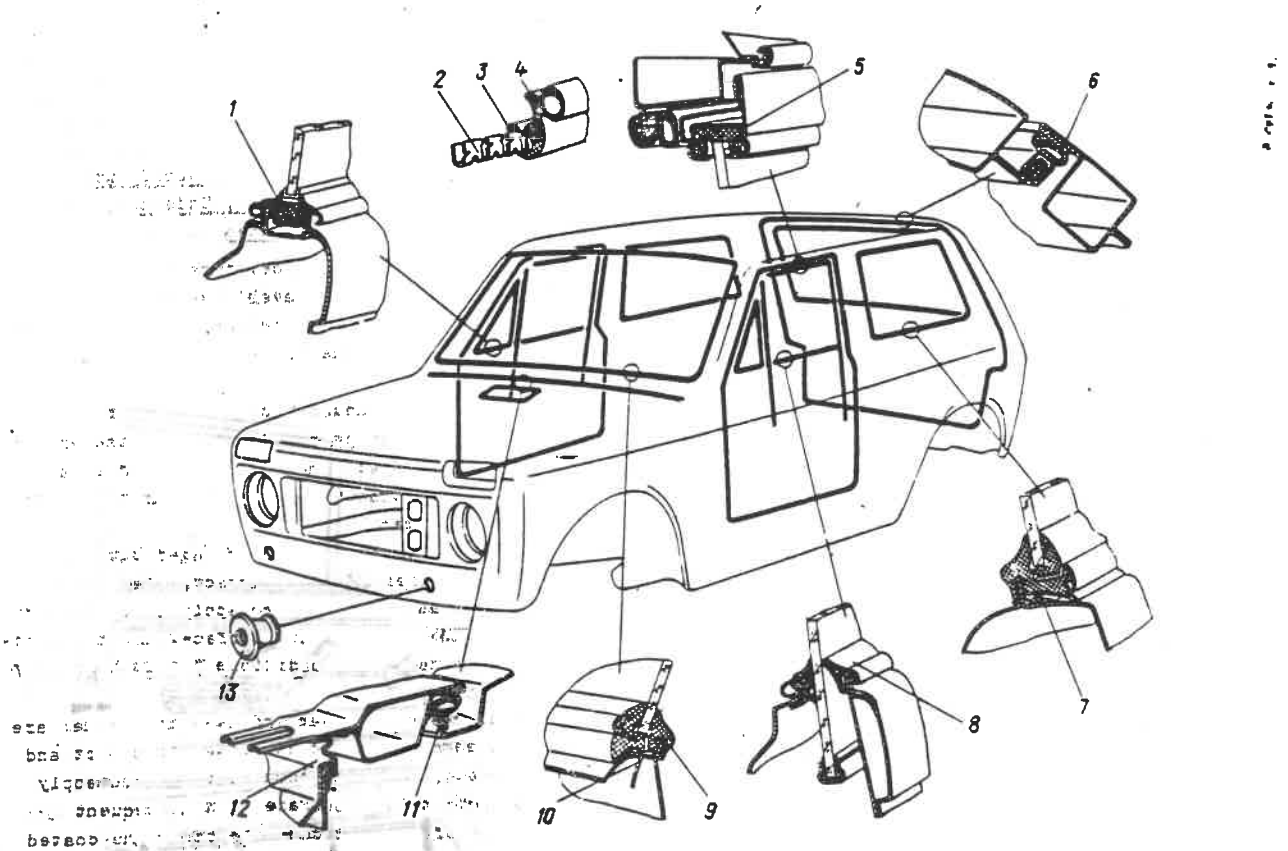

Fig.8-9. Rubber Sealing Strips:
1 - vent window glass; 2 - front door sealing strip reinforcement; 3 - sealing strip edging; 4 - front door shut sealing strip; 5 - drop window glass sealing strip; 6 - tailgate shut sealing strip; 7 - side window sealing strip; 8 - drop window glass lower sealing strip; 9 - windshield sealing strip; 10 - drain pipe; 11 - hood sealing strip; 12 - air intake box sealing strip; 13 - front bumper connector

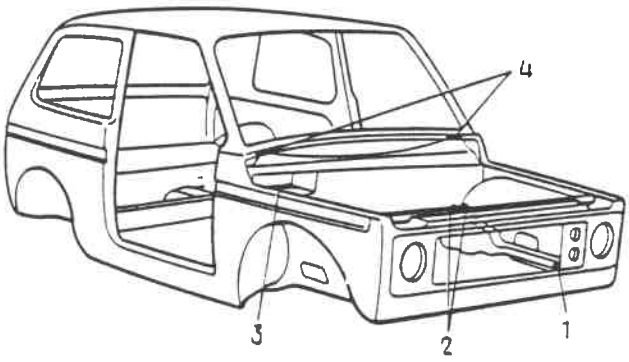

Fig.8-10. Points of Application of 51-Г-7 Sealant (Front View of Body):
1 - front sidemember-to-radiator frame joint;
2 - front sidemember-to-dash panel joints;
3 - storage battery pan-to-dash panel joint (on body interior side); 4 - dash panel-to-body front strip joints (from engine compartment side)

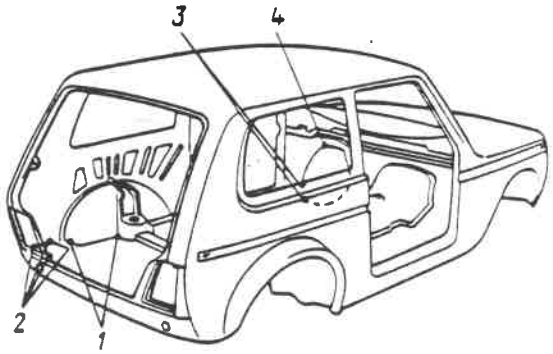

Fig.8-11. Points of Application of 51-Г-7 Sealant (Rear View of Body):
1 - rear floor-to-rear wheel arch joints;
2 - slots in corner joints of rear floor extensions with rear wheel arches, body sides and body rear panel; 3 - corner joints of dash panel with floor sill; 4 - dash panel corner with body side front pillar panel

DOORS

Removal and Installation of Front Door

Open the door all the way and detach the door check, driving out the pin which fastens the check to the body front pillar.

Holding the door open and using impact screwdriver 2 (Fig. 8-12), turn out screws 1 which fasten the door hinges to the body pillar, and remove the door.

To install the door, reverse the removal operations.

Before final tightening of screws 1 adjust the gaps between the door and the car body.

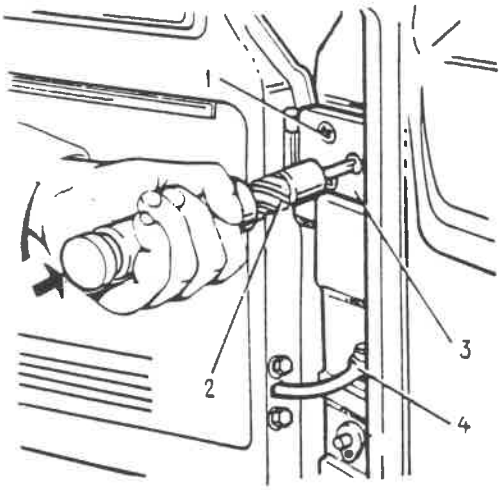

Fig.8-12. Removing Front Door:
1 - hinge screw; 2 - impact screwdriver; 3 - hinge; 4 - door check. Arrow shows direction of impact

Disassembly and Assembly of Front Door

Disassemble the door, if some of its parts and mechanisms have to be repaired or replaced.

Turn off the armrest screws, first taking off plastic decorative plug 1 (Fig. 8-13) of the upper screw, and remove the armrest.

Force off escutcheon 20 (Fig. 8-14), take out circlip 1 with remover A.78014 and take off window regulator handle 22.

Take off the facing of the inner lock handle with a screwdriver.

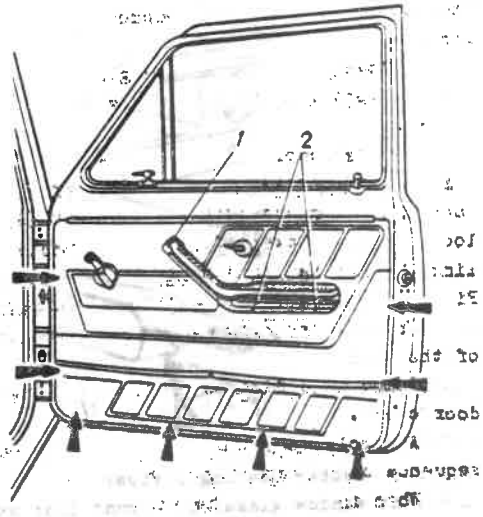

Fig.8-13. Front Door Inside View:
1 - armrest upper screw plug; 2 - armrest lower screws. Arrows show location of door trim panel holders

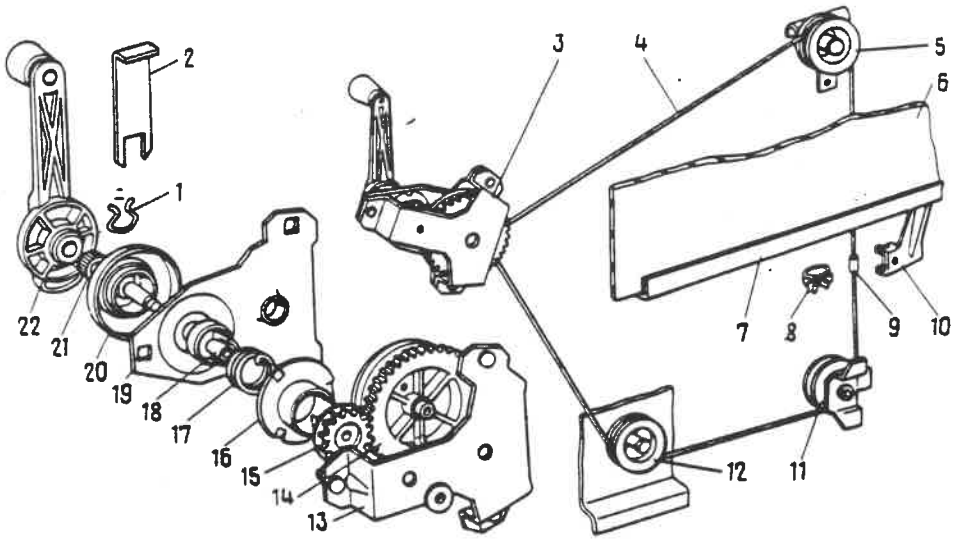

Fig.8-14. Drop Window Regulator:
1 - circlip; 2 - circlip remover K.78034; 3 - regulator mechanism; 4 - cable; 5 - upper roller; 6 - drop window glass; 7 - drop window glass channel; 8 - cable holder; 9 - cable coupling; 10 - glass channel bracket; 11 - lower roller; 12 - tension roller; 13 - regulator mechanism body; 14 - drum with driven gear; 15 - drive gear; 16 - drive shaft support; 17 - brake spring; 18 - spring brake carrier; 19 - body cover; 20 - escutcheon; 21 - drive shaft; 22 - window regulator handle

Remove the door trim panels overcoming the resistance of the plastic spring holders (shown by arrows in Fig. 8-13).

Raise the drop window glass, turn out the fastening screws and remove the front and rear glass guide runs.

Lower the glass, loosen the nuts of the window regulator tension roller, disconnect the cable from the drop-window glass channel, slip the cable off the rollers and take out the glass through the lower opening of the door. Unscrew the nuts and remove the window regulator mechanism.

Remove the drop-window glass sealing strips and the vent glass assembly by turning off the screws.

Unscrew door lock button 6 (Fig. 8-15), turn out the screws of bracket 4 of lock inner handle 1, turn out screws 3 (Fig. 8-16) of the lock body and take off the lock complete with the links, first having disconnected link 20 (see Fig. 8-15) from the lock release carrier.

Unscrew two nuts and remove the outer handle of the door.

Remove two fastening bolts and take off the door check.

Assemble the front doors in the reverse sequence of disassembly operations.

When installing the window regulator, see that the cable wraps are not laid one on the other on the drum. Adjust tension of cable 2 (Fig.8-17) and smooth functioning of the window regulator by shifting the tension roller; for this purpose loosen nut 3.

Before installing the door trim panels, examine the plastic holders.

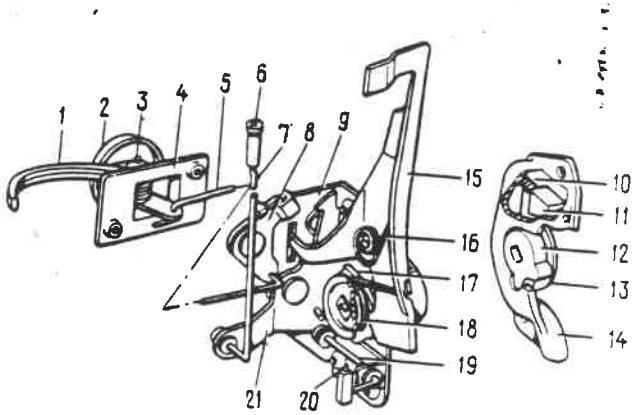

Fig.8-15. L.H. Front Door Lock:
1 - lock inner handle; 2 - inner handle facing; 3 - axle; 4 - inner handle bracket; 5 - inner handle rod; 6 - door lock button; 7 - door lock button rod; 8 - inner lock release lever; 9 - lock body; 10 - block spring; 11 - block; 12 - rotor; 13 - central shaft support; 14 - striker plate body; 15 - outer lock release lever; 16 - outer lock release lever spring; 17 - ratchet; 18 - ratchet spring; 19 - lock release shaft; 20 - lock release link; 21 - door lock lever

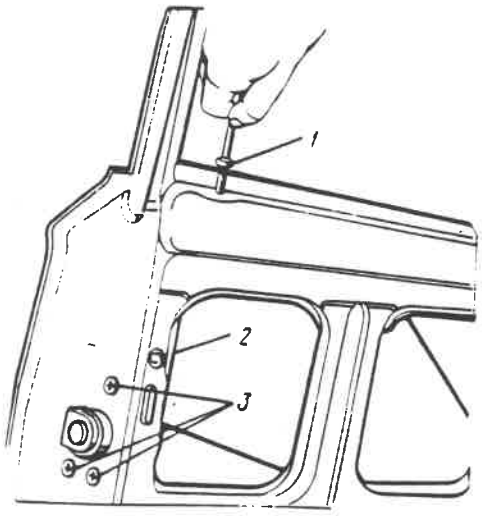

Fig.8-16. Front Door Lock Fastenings:
1 - door lock button; 2 - lock button rod;
3 - lock fastening screws

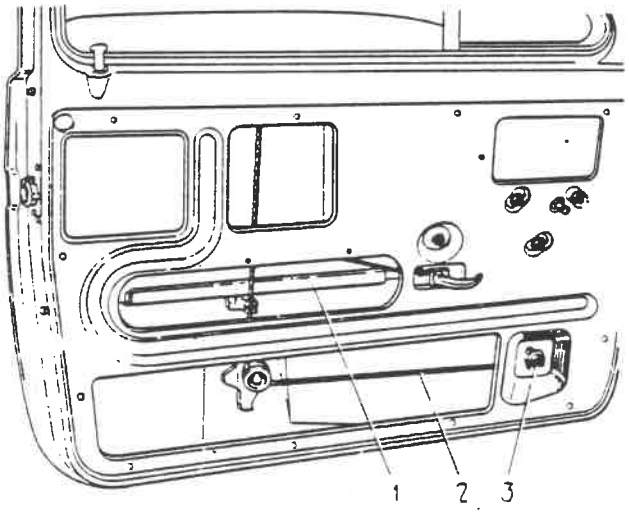

Fig.8-17. Adjusting Window Regulator Cable Tension:
1 - drop window glass channel; 2 - cable; 3 - tension roller bolt nut

Adjustment of Front Door Position

Before adjustment, mark out the contours of the hinges on the body pillar. Using impact screwdriver 2 (Fig. 8-12), loosen hinge screws 1.

Set the required external clearances by displacing the hinges relative to the marked-out contour and turn in the screws.

Adjustment of Front Door Locks

To ensure trouble-free operation of the door lock, adjust the position of striker plate body 14 (Fig. 8-15), first loosening its fastening bolts.

Before adjustment it is recommended to mark out the outline of the striker plate on the body pillar.

If the door closes too tightly loosen the bolts, shift the striker plate outward and tighten the bolts.

If the door closes loosely, shift the striker plate inward. The door should neither sink, nor project relative to the body.

If the door sags after closing, move the striker plate upward; if it rises after closing (sagging when open), shift the striker plate down.

If it is difficult to open the door by inner handle 1, adjust the handle position. For this purpose, loosen the fastening screws and shift the handle with the bracket as required.

Tighten the fastening screws after adjustment.

Removal, Installation and Adjustment of Tailgate

The tailgate is mounted on the body by two hinges 2 (Fig. 8-18) and is locked. When open, it is held by two nonseparable gas-filled hydraulic props 9.

Detach the props from the tailgate by turning the prop pins out of the welded-to nuts. Unscrew the tailgate-to-hinge nuts and remove the tailgate having disconnected the wiper wires and washer tube.

When installing, adjust the position of the tailgate in the body opening with the aid of the oval holes for the hinge studs, then tighten the nuts home.

If the tailgate lock closes with difficulty, adjust it by shifting its body 4 (Fig. 8-1[illegible]) or striker plate 5 as required.

Replace the gas-filled props by new ones, if they fail to hold the door open.

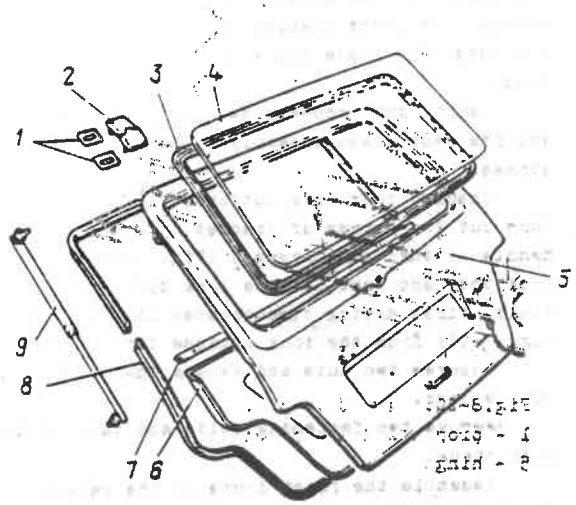

Fig.8-18. Tailgate:
1 - gasket; 2 - hinge; 3 - glass sealing strip;
4 - glass; 5 - door; 6 - door trim panel
7 - strip; 8 - shut sealing strip; 9 - tailgate gas-filled prop

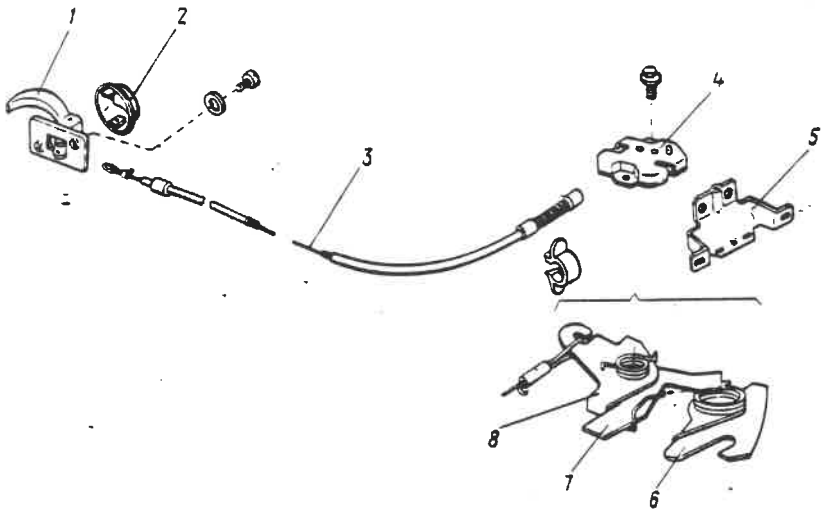

Fig.8-19. Tailgate Lock:
1 - lock operating handle; 2 - handle escutcheon; 3 - operating rod; 4 - lock body; 5 - lock striker plate; 6 - rotor; 7 - lever; 8 - return lever

HOOD, BUMPERS

Removal, Installation and Adjustment of Position of Hood

Open hood 3 (Fig. 8-20), uncotter axle 1 of prop 2 and detach the latter from the hood.

Supporting the hood, unscrew bolts 4 of the upper plates of hinges 5 and take off the hood.

Install the hood in the reverse order of operations.

When installing, adjust the position of the hood, making use of enlarged holes in the hinges.

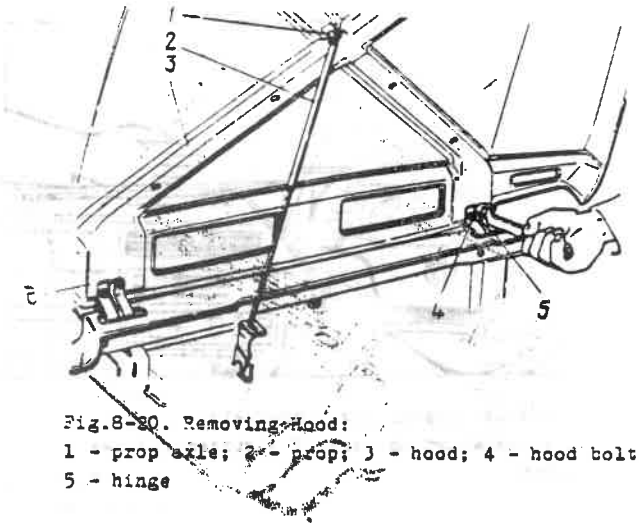

Fig.8-20. Removing Hood:
1 - prop axle; 2 - prop; 3 - hood; 4 - hood bolt; 5 - hinge

Adjustment of Hood Lock

If the lock is not reliable in closing the hood or opens with difficulty, adjust its position (Fig. 8-21).

Open the hood, mark out the contours of lock body 1, loosen the fastening nuts and shift the lock body in the required position, using the enlarged holes.

Tighten the fastening nuts and check functioning of the lock.

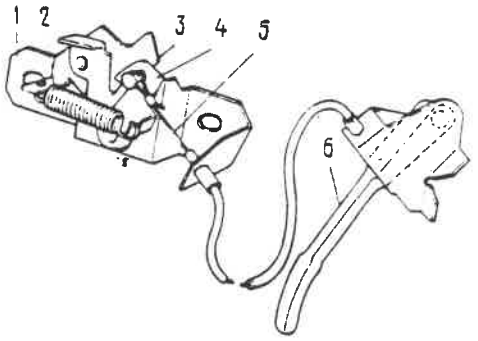

Fig.8-21. Hood Lock:
1 - lock body; 2 - spring; 3 - pusher; 4 - hook; 5 - control cable; 6 - control handle

Removal and Installation of Bumpers

The bumpers are made of aluminium shapes whose face wall is provided throughout the length of the bumper with black rubber strip 8 (Fig.8-22), and the ends of the bumpers are fitted with black plastic side covers 6.

Each bumper is held to the body by two bolts; to remove the bumper, these bolts must be unscrewed.

Install the bumpers in the reverse order of operations.

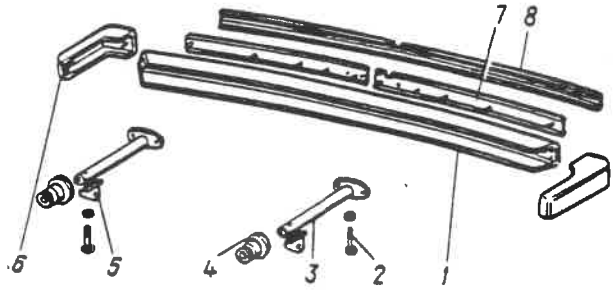

Fig.8-22. Front Bumper Assembly:
1 - bumper; 2 - fastening bolt; 3 - connector; 4 - rubber seal; 5 - tow lug; 6 - plastic side cover; 7 - cover holder; 8 - rubber strip

WINDOW GLASSES AND GLASS WASHERS

Replacement of Windshield Glass

To take out the damaged glass, remove the wiper arms, sealing strip edging and, pressing on the upper corners of the glass, push it outward. An assistant should support the glass from the outside (Fig. 8-23). Remove the sealing strip from the glass.

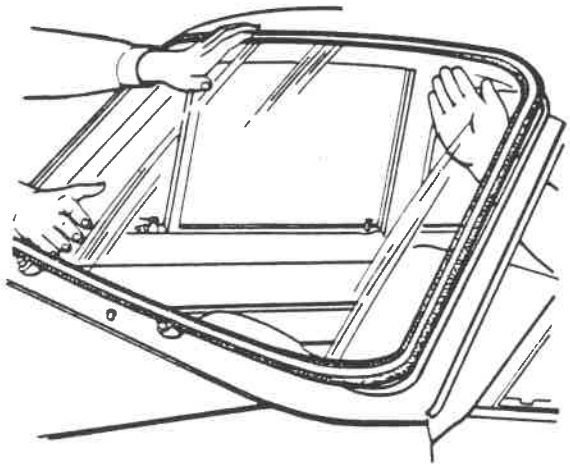

Fig.8-23. Removing Windshield

To install the windshield glass:

- wash the recesses of sealing strip 9 (Fig. 8-9) with water and blow them out with compressed air;
- slip the sealing strip on the glass;
- coat with glycerol or soapy water the channel of sealing strip 2 (Fig. 8-24) which should be fitted on the body flange;
- using a screwdriver, insert installation cord 1 into the recess;
- fit the glass into the body opening and pull at the ends of cord 1 from inside the body until the glass with sealing strip 2 snaps in position. The assistant should press the glass gently from the outside.

If the glass fails to be installed, check the body aperture by fitting the glass without the sealing strip. True up the aperture by straightening out.

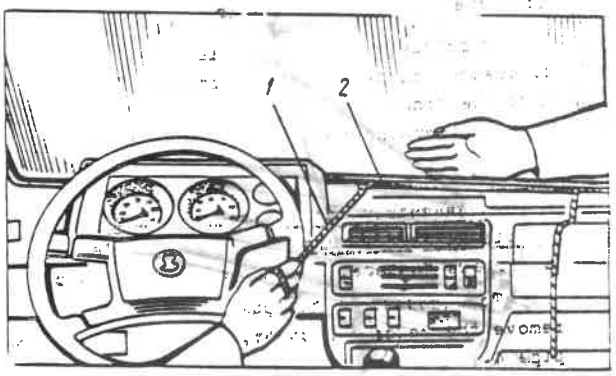

Fig.8-24. Installing Windshield:
1 - installation cord; 2 - windshield sealing strip

Replacement of Side and Tailgate Glasses

To remove the glasses take off the sealing strip edging and, pressing on the lower corners of the glass, push it outward. An assistant should support the glass from the outside.

Installation of the glasses is similar to that of the windshield glass.

Glass Washers

A schematic diagram of the glass washers is shown in Fig. 8-25.

The tailgate glass washer has its own tank installed in the trunk compartment.

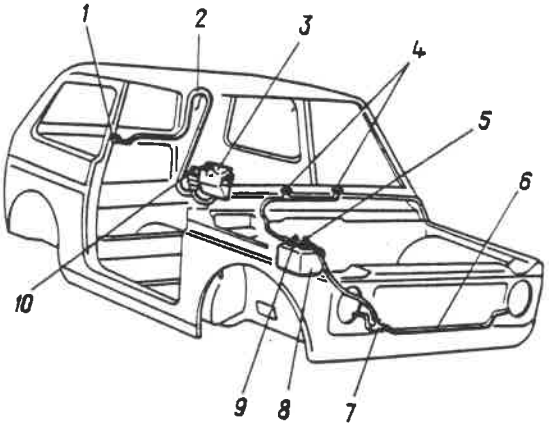

Fig.8-25. Washers Diagram:
1 - tailgate glass washer nozzle; 2 - hose from pump to nozzle; 3 - tailgate glass washer tank; 4 - windshield washer nozzles; 5 - headlight washer pump; 6 - hose to headlight washer nozzle; 7 - tee-pipe; 8 - windshield and headlight washers tank; 9 - windshield washer pump; 10 - tailgate glass washer pump

Removal and installation of windshield and headlight washer pump. Disconnect the electric wires from motor 1 (Fig. 8-26) and take the pipe from the union of the washer pump.

Turn cover 2 with the electric motor counter-clockwise and take them off complete with the pump from the tank.

To install, reverse the removal operations.

Disassembly and assembly of windshield and headlight washer pump. The pump and electric motor are fastened by screws and nuts to cover 2.

To disassemble the pump, turn out the screws, remove the motor and cover, detaching fluid feed pipe 4.

Insert a pointed tool under the edge of rim 8 and take it off complete with the filter screen.

Remove coupling 3 and, tapping gently at shaft 6 of rotor 9, push out support 7 and take out the shaft with the rotor.

To assemble, proceed in the reverse sequence of operations.

Removal and installation of washer nozzles. To remove the nozzle compress slightly the catches of plastic body 1 (Fig. 8-27) from the side of the engine compartment, pry the nozzle with a screwdriver from the top and overcoming the resistance, take out the nozzle complete with its atomizer.

Disconnect the pipe and blow through atomizer 2 and the body with compressed air.

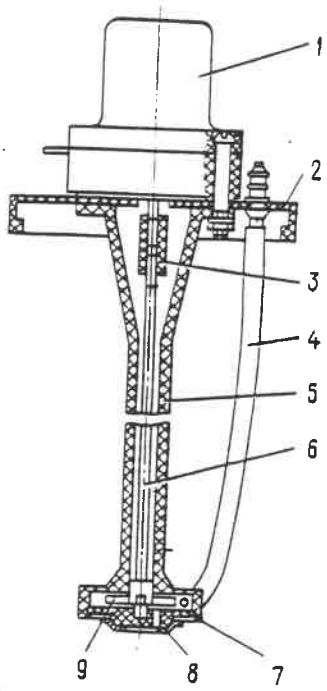

Fig.8-26. Washer Pump:
1 - electric motor; 2 - tank cover; 3 - coupling; 4 - fluid feed pipe; 5 - pump casing; 6 - rotor shaft; 7 - rotor shaft support; 8 - rim with filter screen; 9 - rotor

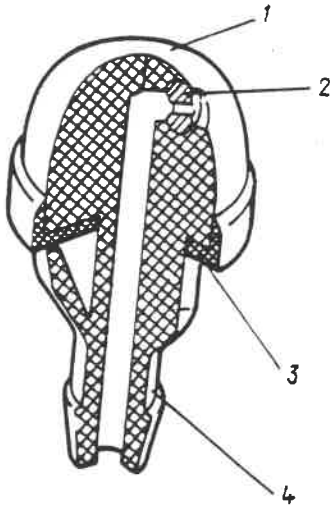

Fig.8-27. Washer Nozzle:
1 - nozzle body; 2 - atomizer; 3 - gasket; 4 - union

To install the nozzle drive its body sharply into the hole in the car body.

Adjust the direction of the liquid spray by changing the position of the atomizer in the body socket. For this purpose insert a needle into the nozzle atomizer hole and carefully turn the atomizer to make the liquid spray get to the correct zone on the glass.

INSTRUMENT PANEL, SEATS

Removal and Installation of Instrument Panel

Disconnect the minus wire from the storage battery.

Remove the lining of the windshield pillars, the casing of the steering column and case 14 (Fig.8-28) of the instrument cluster, and the instrument cluster (see Section "Electrical Equipment) and disconnect the sockets and plugs of the car electric harness.

Remove the instrument illumination switch knob, turn out the attachment nut and push the switch below the instrument panel level.

Turn out the screws of shelf 9, and radio set panel 13; disconnect the wires from the radio set, cigarette lighter, windshield and headlight wiper and washer switch, distress light switch.

Turn out the screws and remove glove box body 4.

Remove the handles from the heater control levers. For this purpose bend off with a sharp flat tool the lower part in the upper handle and the upper parts in the middle and lower handles.

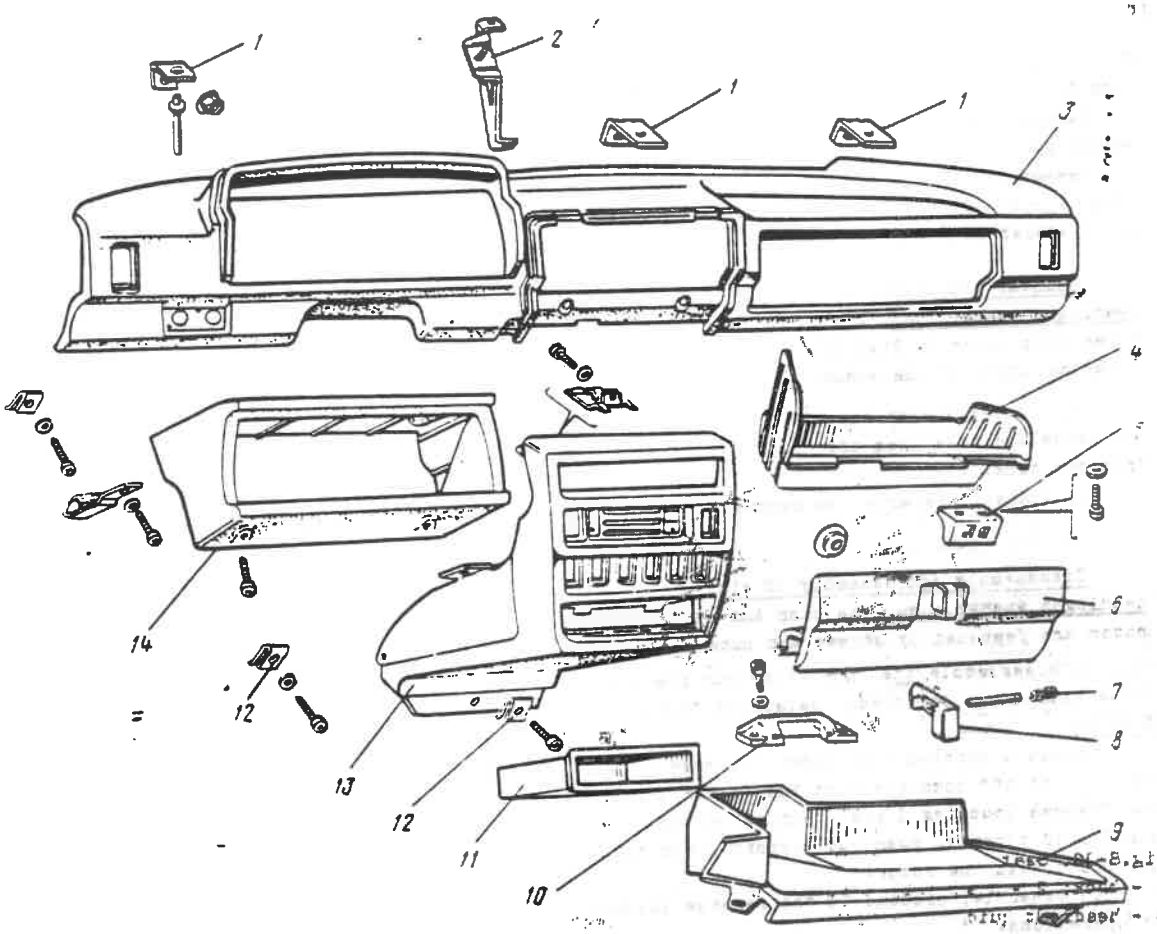

Fig.8-28. Instrument Panel and Its Accessories:
1 - attachment bracket; 2 - reinforcement; 3 - instrument panel; 4 - glove box body; 5 - lid lock stop; 6 - glove box lid; 7 - lock spring; 8 - lid lock; 9 - shelf; 10 - lid hinge link; 11 - small articles box; 12 - attachment clips; 13 - radio set panel; 14 - cluster case

Turn out four screws (shown by arrows in Fig. 8-29) holding instrument panel 3 to the front crossmember in the lower part; through the apertures of the glove box and instrument panel case turn out four nuts which hold the panel to the front end and remove the instrument panel.

When necessary, remove the air ducts and ventilating central and side nozzles from the instrument panel.

To install the instrument panel proceed in the reverse sequence.

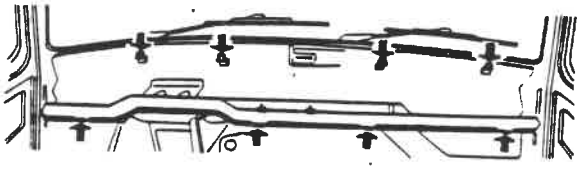

Fig.8-29. Instrument Panel Fastening Points (Shown by arrows).

Removal and Installation of Seats

The construction of the seats is shown in Figs 8-30, 8-31 and 8-32.

Front seats. To remove the seat move it in the extreme front position and turn out the rear bolts holding the guides to the body floor.

Move the seat backwards to stop, turn out the front bolts holding the guides and remove the seat complete with the adjusters.

To install the seat reverse the removal operations.

Rear seat. Force off retainers 9 (Fig. 8-30) of the seat back, turn out the bolts holding the cushion hinges to the floor crossmember and remove the seat.

To install the seat reverse the removal operations.

Disassembly and Assembly of Front Seat Rails

Carry out the disassembly with the seats removed.

Raise handle 2 (Fig. 8-31) and shift guides 10 of the rails relative to the sliders until rollers 9 and stop 7 come out. Remove the rail guides.

To assemble put the rollers with the stop into the slider slot and slip the guide onto the slider, then release handle 2.

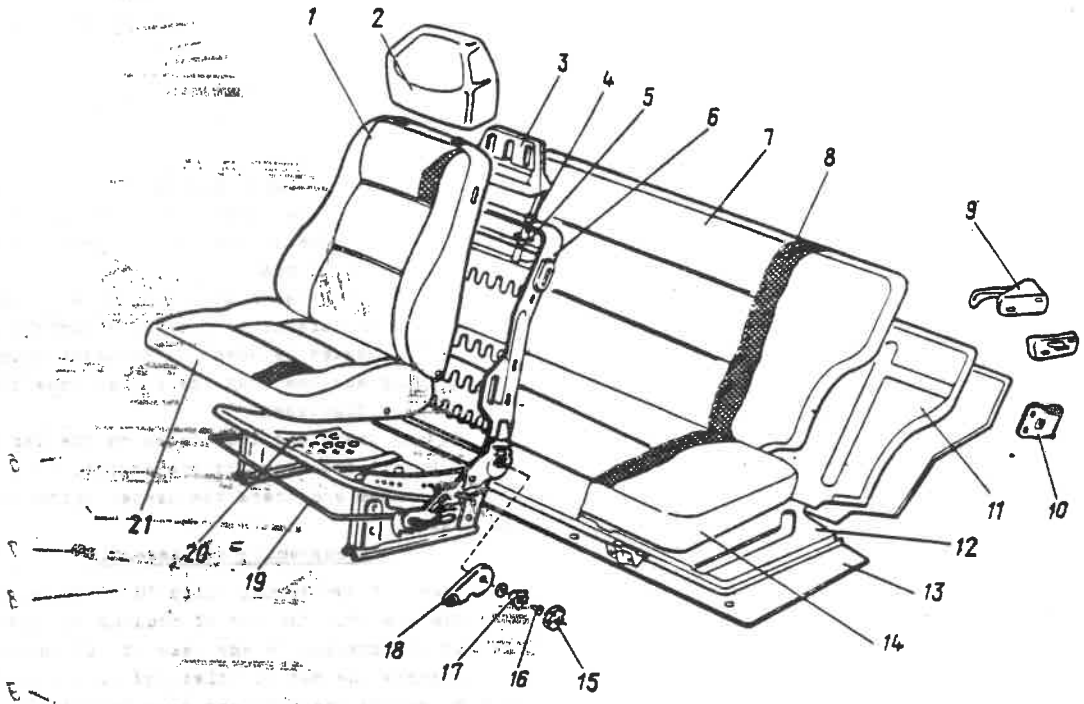

Fig.8-30. Seats:
1 - back; 2 - headrest; 3 - headrest frame; 4 - headrest guide; 5 - cotter pin; 6 - front seat back frame; 7 - rear seat back upholstery; 8 - rear seat upholstery backing; 9 - seat back retainer; 10 - seat back shackle; 11 - seat back base; 12 - cushion base; 13 - mat; 14 - rear seat cushion padding; 15 - back rake adjuster handle; 16 - holder attachment bolt; 17 - back rake adjuster handle holder; 18 - back rake adjuster facing; 19 - seat fore-and-aft adjuster handle; 20 - front seat cushion frame; 21 - front seat cushion

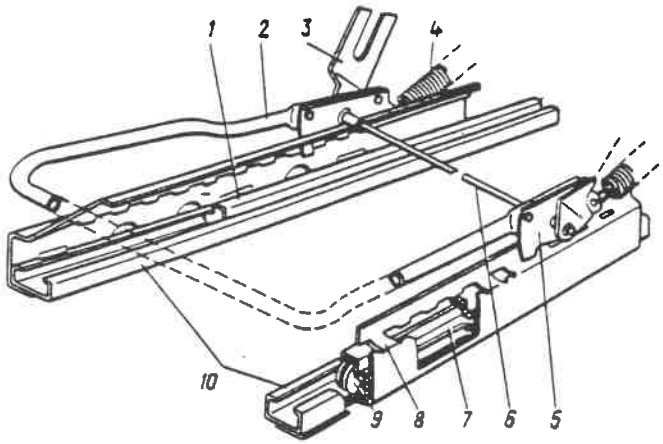

Fig.8-31. Front Seat Rails:
1 - slider; 2 - seat fore-and-aft adjuster handle;
3 - back rake adjuster lower link lever;
4 - seat moving spring; 5 - catch; 6 - catch axle;
7 - stop; 8 - lock; 9 - roller; 10 - rail guides

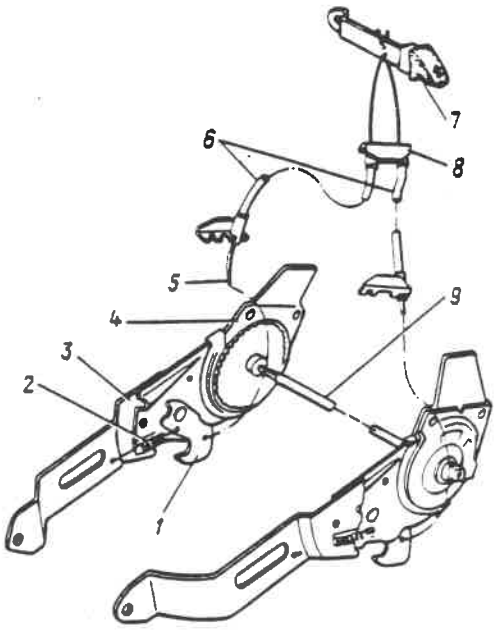

Fig.8-32. Front Seat Back Rake Adjuster and Reclining Mechanism:
1 - hook; 2 - hook spring; 3 - back rake adjuster lower link lever; 4 - back rake adjuster upper link; 5 - back reclining mechanism rod; 6 - rod sheathing; 7 - reclining mechanism lever handle; 8 - bracket; 9 - synchronizer

HEATER

Removal and Installation

To remove the body heater:

- shift control lever 6 (Fig.8-33) of heater cock 17 all the way to the right and drain the engine cooling system;
- detach the "ground" wire from the storage battery;
- turn out the fastening screws, remove the instrument panel shelf and radio set panel, disconnect the wires;
- loosen the clamps and disconnect the coolant inlet and outlet rubber hoses from heater pipes 16;
- unscrew two fastening bolts in the engine compartment and take off the seal of the heater radiator pipes;
- loosen the bolt of the flexible rod casing clip on the cock and take the rod off the cock;
- remove the switch of the heater fan motor and disconnect its wires;
- remove four spring holders and heater fan housing 18 in assembly with the fan;
- remove the instrument panel case, through the case aperture back off the screws of the clips of the flexible rods of air intake lid 12 and windshield demisting air duct shutter 3. Remove the rods from the control levers;
- unscrew the nuts holding radiator housing 15 to air intake box 14, disconnect the "ground" wire from under one of the nuts, remove the housing and the air intake box.

Install the heater in the reverse order of operations. Be careful to provide a correct position of the gasket between the radiator housing and the car body and see that the rubber hose clamps are properly tightened.

Having installed the heater on the car and connected all the hoses to the engine, fill the cooling system and check the heater connections for leaks.

Disassembly and Assembly

Take off two spring clips 16 (Fig. 8-34) and take the electric fan out of housing 4. Unscrew the nut of impeller 14 and take it off motor 15.

Unscrew the nut of inlet and outlet pipe clip 8, remove the clip and take radiator 11 out of housing 5.

Unscrew the clip nut and take off air intake lid 7.

Unscrew the nuts of the clips and remove air-distributing cover 1 of the fan housing.

Assemble the heater in the reverse sequence of operations.

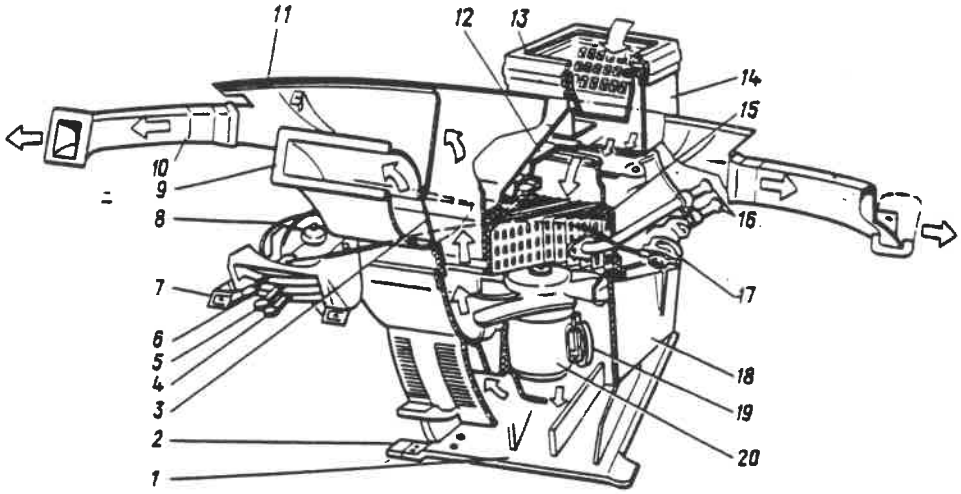

Fig.8-33. Heater:
1 - air distributing cover; 2 - air distributing cover lever; 3 - windshield demisting air duct shutter; 4 - windshield demisting shutter control lever; 5 - air intake lid control lever; 6 - cock control lever; 7 - control lever bracket; 8 - flexible rod; 9 - body ventilating air duct; 10 - side glass demisting air duct; 11 - windshield demisting air duct; 12 - air intake lid; 13 - air intake box seal; 14 - air intake box; 15 - radiator; 16 - inlet and outlet pipes; 17 - cock; 18 - fan housing; 19 - spring clip; 20 - fan motor

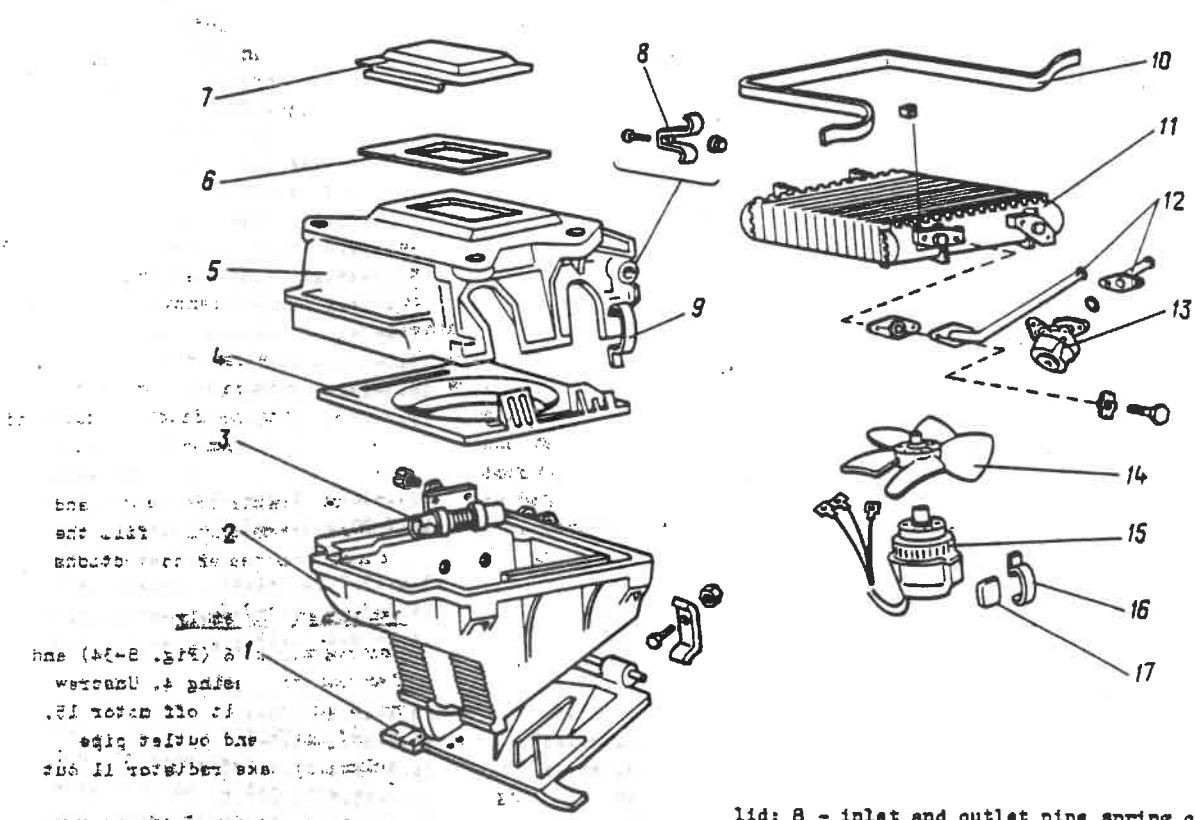

Fig.8-34. Heater Parts:
1 - air distributing cover; 2 - fan housing; 3 - resistor; 4 - guide housing; 5 - radiator housing; 6 - air intake lid gasket; 7 - air intake lid; 8 - inlet and outlet pipe spring clip; 9 - fan housing spring holder; 10 - radiator gasket; 11 - radiator; 12 - inlet and outlet pipes; 13 - cock; 14 - fan impeller; 15 - motor; 16 - spring clip; 17 - motor pad

Appendix I

Tightening Torques for Threaded Joints

Part	Thread	Tightening torque, N.m (kgf.m)
Engine		
Bolt, main bearing cap	M10x1.25	68.31-84.38 (6.97-8.61)
Bolt, oil pump	M6	5.10-8.20 (0.52-0.85)
Stud, breather cover	M8	12.7-20.6 (1.3-2.1)
Nut, breather cover	M8	12.7-20.6 (1.3-2.1)
Bolt, cylinder head	M12x1.25	See "Engine"
Bolt, cylinder head	M8	31.36-39.1 (3.2-3.99)
Nut, intake and exhaust manifolds stud	M8	20.87-25.77 (2.13-2.63)
Nut, connecting rod cap bolt	M9x1	43.32-53.51 (4.42-5.46)
Bolt, flywheel	M10x1.25	60.96-87.42 (6.22-8.92)
Bolt, chain tensioner shoe	M10x1.25	41.2-51.0 (4.2-5.2)
Bolt, cylinder head cover	M6	1.96-4.60 (0.20-0.47)
Nut, camshaft bearing housing	M8	18.33-22.64 (1.87-2.3)
Bolt, oil pump drive shaft sprocket	M10x1.25	41.2-51.0 (4.2-5.2)
Bolt, camshaft sprocket	M10x1.25	41.2-51.0 (4.2-5.2)
Nut, valve adjusting bolt	M12x1.25	43.3-53.5 (4.42-5.46)
Bushing, valve adjusting bolt	M18x1.5	83.3-102.9 (8.5-10.5)
Spark plug	M14x1.25	30.67-39 (3.13-3.99)
Bolt, coolant pump	M8	21.66-26.75 (2.21-2.73)
Nut, coolant jacket outlet connection	M8	15.97-22.64 (1.63-2.31)
Starting jaws, crankshaft	M20x1.5	101.3-125.64 (10.34-12.8)
Bolt, alternator bracket	M10x1.25	44.1-64.7 (4.5-6.6)
Nut, alternator adjusting brace	M10x1.25	28.03-45.27 (2.86-4.62)
Nut, alternator-to-bracket bolt	M12x1.25	58.3-72.0 (5.95-7.35)
Nut, adjusting brace-to-alternator	M10x1.25	28.03-45.27 (2.86-4.62)
Nut, engine front support bracket	M8	10.4-24.2 (1.1-2.5)
Nut, front support pad-to-crossmember bracket	M10x1.25	27.4-34.0 (2.8-3.46)
Nut, engine rear mount crossmember	M8	15.0-18.6 (1.53-1.9)
Nut, rear engine mount-to-gearbox	M8	28.3-28.8 (2.38-2.94)
Nut, rear engine mount-to-crossmember	M8	15.9-25.7 (1.62-2.62)
Clutch		
Bolt, clutch	M8	19.1-30.9 (1.95-3.15)
Nut, clutch and brake pedals bolts	M12x1.25	12.7-20.6 (1.3-2.1)
Nut, clutch and brake master cylinders and pedals bracket	M8	9.8-15.7 (1.0-1.6)
Nut, clutch hydraulic system connecting pipes	M12	24.5-31.4 (2.5-3.2)
Nut, brake hydraulic system connecting pipes	M10	14.7-18.6 (1.5-1.9)
Gearbox		
Switch, backing light	M14x1.5	28.4-45.1 (2.9-4.6)
Bolts, clutch housing-to-engine	M12x1.25	53.9-87.2 (5.5-8.9)
Nut, clutch housing-to-gearbox	M10x1.25	31.8-51.4 (3.25-5.25)
Nut, clutch housing-to-gearbox	M8	15.7-25.5 (1.6-2.6)
Bolt, shift bar detent cover	M8	15.7-25.5 (1.6-2.6)
Nut, rear cover	M8	15.7-25.5 (1.6-2.6)
Nut, main shaft rear end	M20x1.0	66.6-82.3 (6.8-8.4)
Bolt, countershaft bearing clamping washer	M12x1.25	79.4-98 (8.1-10.0)
Bolt, fork-to-shift bar	M6	11.7-18.6 (1.2-1.9)

Part	Thread	Tightening torque, N.m (kgf.m)
Transfer Case		
Nut, mount bracket-to-pad pivot	M10x1.25	26.5-32.3 (2.7-3.3)
Nut, mount bracket-to-body	M8	15.0-18.6 (1.53-1.9)
Nut, transfer case housing covers, front axle drive housing, speedometer drive housing, control lever bracket	M8	14.7-24.5 (1.5-2.5)
Switch, differential lock	M16x1.5	28.4-45 (2.9-4.6)
Bolt, fork-to-shift bar	M6	11.8-18.6 (1.2-1.9)
Bolt, fork-to-differential lock bar	M12x1.25	11.7-18.6 (1.2-1.9)
Bolt, driven gear	M10x1.25	66.6-82.3 (6.8-8.4)
Nut, drive shaft rear bearing and countershaft rear bearing	M38x1.5	96-117.6 (9.8-12.0)
Nut, propeller shaft flange-to-drive shaft and to front and rear axle drive shafts	M16x1.5	96-117.6 (9.8-12.0)
Propeller Shaft Drive		
Nuts, flexible coupling-to-gearbox and transfer case flange bolts	M12x1.25	57.8-71.5 (5.9-7.3)
Nut of bolt, propeller shaft flange-to-flanges of front and rear axle final drives and transfer case	M8	27.4-34.3 (2.8-3.5)
Front Axle		
Bolt, front axle-to-engine	M12x1.25	74.5-92 (7.6-9.4)
Nut, front axle-to-engine	M12	60.8-75 (6.2-7.66)
Bolt, front axle-to-engine	M10x1.25	42.1-52 (4.3-5.3)
Nut, inner joint housing bearing cover	M8x1.25	19.6-24.5 (2.0-2.5)
Nut, differential bearing cover	M12x1.25	62.7-75.4 (6.3-7.7)
Bolt, locking plate-to-spring washer	M6x1	3.8-6.2 (0.39-0.63)
Bolt, ring gear	M10x1.25	83.3-102.9 (8.5-10.5)
Rear Axle		
Bolt, final drive housing-to-rear axle beam	M8	35-43.2 (3.57-4.41)
Bolt, differential bearing cover	M10x1.25	43.3-53.5 (4.42-5.46)
Bolt, ring gear	M10x1.25	83.3-102.9 (8.5-10.5)
Nut, drive pinion-to-flange	M16x1.5	See "Rear Axle"
Nut, axle shaft bearing and rear brake	M10x1.25	41.6-51.4 (4.25-5.25)
Steering Gear		
Nut, steering gear case bolt	M10x1.25	33.3-41.2 (3.4-4.2)
Nut, idler arm bracket bolt	M10x1.25	33.3-41.2 (3.4-4.2)
Nut, steering rod ball pin	M14x1.5	42.1-53 (4.3-5.4)
Nut, intermediate steering shaft-to-upper steering shaft and to worm shaft	M8	22.5-27.4 (2.3-2.8)
Nut, steering wheel	M16x1.5	31.4-51 (3.2-5.2)
Nut, steering shaft bracket and ignition switch	M8	15-18.6 (1.53-1.9)
Nut, pitman arm	M20x1.5	199.9-247 (20.4-25.2)
Nut, idler arm shaft	M14x1.5	63.7-102.9 (6.5-10.5)
Front Suspension		
Nut, crossmember-to-body side member lower bolts	M12x1.25	66.6-82.3 (6.8-8.4)
Nut, crossmember-to-body side member upper bolts	M12x1.25	66.6-82.3 (6.8-8.4)
Nut, rebound buffer bracket-to-crossmember bolt	M8	15.1-18.6 (1.53-1.9)
Nut, upper wishbone shaft bolt	M12x1.25	66.6-82.3 (6.8-8.4)
Nut, shock absorber upper end	M10x1.25	27.4-34 (2.8-3.46)
Nut, shock absorber lower end	M10x1.25	50-61.7 (5.1-6.3)
Nut, front wheel hub bearings	M18x1.5	See 'Running gear'
Bolt, brake caliper-to-steering knuckle	M10x1.25	29.1-36 (2.97-3.67)

Part	Thread	Tightening torque, N.m (kgf.m)
Nut, sway eliminator bar	M8	15-18.6 (1.53-1.9)
Nut, ball pins-to-steering knuckle	M14x1.5	83.3-102.9 (8.5-10.5)
Nut, tension member-to-suspension crossmember	M12x1.25	66.6-82.3 (6.8-8.4)
Nut, tension member-to-body	M16x1.5	104.9-169.5 (10.7-17.3)
Nut, lower wishbone shaft-to-crossmember	M16x1.5	114.7-185.2 (11.7-18.9)
Nut, ball support-to-wishbone	M8	20.6-25.75 (2.1-2.63)
Nut, wheel bolt	M12x1.25	62.4-77.1 (6.37-7.87)
Nut, upper wishbone shaft	M14x1.5	63.7-102.9 (6.5-10.5)
Nut, knuckle arm bolts	M12x1.25	66.6-82.3 (6.8-8.4)
Rear Suspension		
Nut, shock absorber	M12x1.25	38.2-61.7 (3.9-6.3)
Nut, transverse and longitudinal radius rod bolts	M12x1.25	66.6-82.3 (6.8-8.4)

* If the cut in the nut fails to align with the hole for cotter pin, tighten the nut (through an angle less than 60°) to provide cottering.

When tightening, the torques may be rounded off to the nearest decimal value of kgf.m within the permissible torque limits.

Repair and Maintenance Tools*

Designation	Name
	Engine
A.40005	Set of multi-purpose removers
A.40026	Remover, coolant pump impeller
A.50088	Wrench, intake and exhaust manifold nuts
A.50113	Wrench, engine sump oil drain plug
A.50121	Wrench, crankshaft pulley bolt
A.50126	Wrench, cylinder head bolt tightening test (with camshaft installed)
A.60153/R	Mandrel for pressing inlet and exhaust valve guides in and out
A.60311/R	Engine valve removal and installation tool
A.60312	Remover, oil filter
A.60326/R	Driver for pressing oil pump and ignition distributor drive gear bushing out of cylinder block
A.60330/R	Tool, flywheel fixing
A.60333/1/2	Driver for pressing oil pump drive shaft bushing in and out
A.60334	Tester, cylinder head tightness
A.60430	Installation tool, coolant pump impeller
A.86010	Installation driver, crankshaft plug
A.90310	Set of reamers, valve guide bushings
A.90353	Reamer, oil pump, ignition distributor and fuel pump drive shaft bushings

Designation	Name
A.94003	Counterbore (75°) inlet valve seats
A.94016	Spindle, plug socket counterbore
A.94016/10	Counterbore, crankshaft plug socket
A.94031	Counterbore (20°), exhaust valve seats
A.94058	Mandrel, valve seat counterbore
A.94059	Set of pilot spindles, valve seat refacing
A.94069	Mandrel, valve seat grinding wheel
A.94078	Grinding wheel, exhaust valve seats
A.94092	Counterbore, exhaust valve seats
A.94100	Grinding wheel, inlet valve seats
A.94101	Counterbore (20°), inlet and exhaust valve seats
A.95111	Feeler gauge, camshaft rocker-to-cam clearances
02.7812.9500	Articulated socket wrench (13 mm) for starter and muffler inlet pipe
02.7823.9505	Jig, engine valve installation and removal (alternative of portable tool A.60311/R)
41.7816.4013	Socket wrench (21 mm), valve rocker adjusting bolt guide
41.7853.4010	Installation mandrel, camshaft drive gear
41.7853.4011	Installation mandrel for putting gland bolts (and glands) on crankshaft ends
41.7853.4016	Installation mandrel, valve guide bush oil deflecting caps

Continued

Designation	Name
67.7812.9513	Dynamometer, fan drive belt tension check
67.7812.9514	Wrench, spark plug removal and installation
67.7812.9515	Wrench, spark plug tightening torque check
67.7812.9519	Head, spark plug removal and installation
67.7824.9521	Fixture for checking wear (extension) of camshaft drive chain
67.7834.9506	Fixture for measuring fuel pump pushrod travel
67.7854.9519	Adjustable bushing, fitting standard and oversized pistons, dia. 82 mm
67.8125.9502	Ring gauge (dia. 82 mm) for zeroing internal gauge
67.8151.9505	Gauge, carburettor fuel level control
TCO-3/379	Cross beam, engine removal and installation
EC-106	Test stand, thermostat
	Clutch
A.70017	Tool, clutch pedal spring removal and installation
A.70081	Aligning mandrel, cluth driven disc
67.7813.9503	Repair tool, clutch driven disc
67.7822.9517	Jig, clutch driven disc facing replacement
67.7851.9500	Mandrel for riveting driven disc facings
	Gearbox
A.40006	Remover, clutch shaft front bearing
A.55035	Articulated wrench for gearbox installation and removal
41.7816.4068	Fixing tool, clutch shaft
41.7816.4069	Tool for installation (removing) of gearbox main shaft lock ring
41.7853.4028	Mandrel for installation of main shaft bearing
41.7853.4032	Mandrel for installation of countershaft bearing
41.7853.4038	Mandrel for installation of main shaft gland
67.7853.9958	Mandrel for press-fitting transfer differential bearing
	Propeller Shaft Drive
A.70002S	Clamp for removal and installation of universal coupling
41.8734.4092	Gauge for matching propeller shaft cross bearing lock rings
67.7823.9522	Screw clamp for replacement of propeller shaft crosses

Continued

Designation	Name
67.7853.9533	Mandrel for pressing front wheel drive joint gland ring
67.7853.9537	Mandrel for installation of front wheel drive joint boots
	Drive Axles
A.45008	Remover, final drive pinion rear bearing inner cone
A.45028	Stop for removal of differential case bearing inner cones
A.55085	Wrench, differential bearing nuts
A.70152	Driver for pressing rear bearing inner cone on drive pinion
A.70157	Driver for installation of axle-shaft gland
A.70171	Driver for press-fitting final drive pinion rear bearing outer cup
A.70172	Pair of flanges for installation on ends of rear axle beam to check (straighten) it
A.70184	Dummy pinion for determining shim thickness when adjusting final drive gear backlash
A.70185	Driver for press-fitting final drive pinion front bearing outer cup
A.70198	Driver for pressing out final drive pinion bearing outer cups
67.7823.9530	Tool for installation of axle-shaft lock ring
67.7823.9529	Remover, axle-shaft lock ring
A.95601/R	Tester, axle-shaft lock ring fit
A.95688/R	Tool for adjustment of final drive gear backlash and for tightening differential bearing nuts
A.95690	Thickness gauge, drive pinion adjusting ring
A.95697/5	Head for dynamometer 02.7812.9501
02.7812.9501	Dynamometer for checking friction torque of final drive pinion and steering gear worm shaft bearings
67.7812.9520	Wrench for adjustment of front axle final drive
02.7834.9504	Gauge, axle-shaft end play
67.7823.9516	Remover, rear axle-shaft
67.7853.9559	Stop for removal of differential bearing
67.8701.9508	Bracket with end piece for front axle final drive adjustment tool A.95688/R
	Steering Gear
A.47035	Remover for removal of steering rod ball pins out of pitman arm and idler arm holes
A.47043	Remover, pitman arm
A.74076/1	Fixture for repair of steering gear case

Continued

Designation	Name
A.74076/R	Bracket for fixture A.74076/1 to attach steering gear case
A.74105	Driver for pressing pitman arm shaft bushings in and out
A.74186	Driver for press-fitting worm shaft bearing outer cups
A.90336	Reamer, steering gear case bushings
67.7813.9504	Wrench, steering rod sleeve
67.7824.9516	Remover, steering rod ball pins
67.7853.9541	Mandrel for pressing worm upper bearing outer cup out and in
67.8720.9501	Fixture for checking steering wheel play
	Front Suspension
A.47045	Mandrel for pressing out upper wishbone silent blocks
A.57034/R	Wrench, shock absorber reservoir nut
A.57070	Wrench for removal and installation of front shock absorbers
A.74177/1	Tool for installation of silent blocks in upper wishbone (to be used with fixture 67.7853.9519)
02.8701.9502	Test gauge, front suspension ball joints
67.7820.9514	Crosspiece, engine suspension
67.7820.9520	Fixture, nut upsetting
67.7820.9521	Lever for moving front wheel hub when checking clearance in bearings
67.7823.9514	Remover, wheel hub cap
67.7823.9515	Remover, lower wishbone shaft
67.7823.9517	Fixture for pressing lower wishbone silent blocks in and out
67.7823.9526	Fixture for pressing in and out lower wishbone silent blocks on press
67.7823.9527	Fixture to be used for pressing out upper wishbone silent blocks
67.7824.9513	Set of tools for repair of shock absorbers

Continued

Designation	Name
67.7834.9507	Gauge for taking measurements of clearances in front wheel hub bearings
67.7853.9519	Fixture for pressing upper wishbone silent blocks (to be used with tool A.74177/1)
67.7853.9528	Mandrel for installation of wheel hub cap
67.7853.9534	Washer for pressing out front wheel hub inner bearing outer race
67.7853.9535	Handle for washers used in pressing out wheel hub inner bearing outer race
67.7853.9536	Mandrel for pressing front wheel hub bearing outer race
67.7853.9540	Washer for pressing out wheel hub bearing inner race and gland
67.8732.9501	Gauging mandrel for checking geometrical parameters of front suspension crossmember
	Rear Suspension
67.7820.9517	Set of tools for replacement of rear suspension radius rod joints
	Brakes
A.56124	Wrench, rear brake pressure regulator plug
67.7820.9519	Fixture for installation of rear brake pressure regulator
67.7823.9519	Remover, brake drum
	Electrical Equipment
02.7823.9504	Remover, alternator pulley
	Body
A.78034	Remover, window regulator handle circlip

* The tool sets delivered to the Customer are indicated in separate list.

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Внешторгиздат. Изд.№ 3996А
Автомобиль ВАЗ-2121З
Руководство по ремонту на англ. яз.
ВТИ Зак. 6312